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Technology in the United States: Issues and options for the 1970's

Also in this issue:

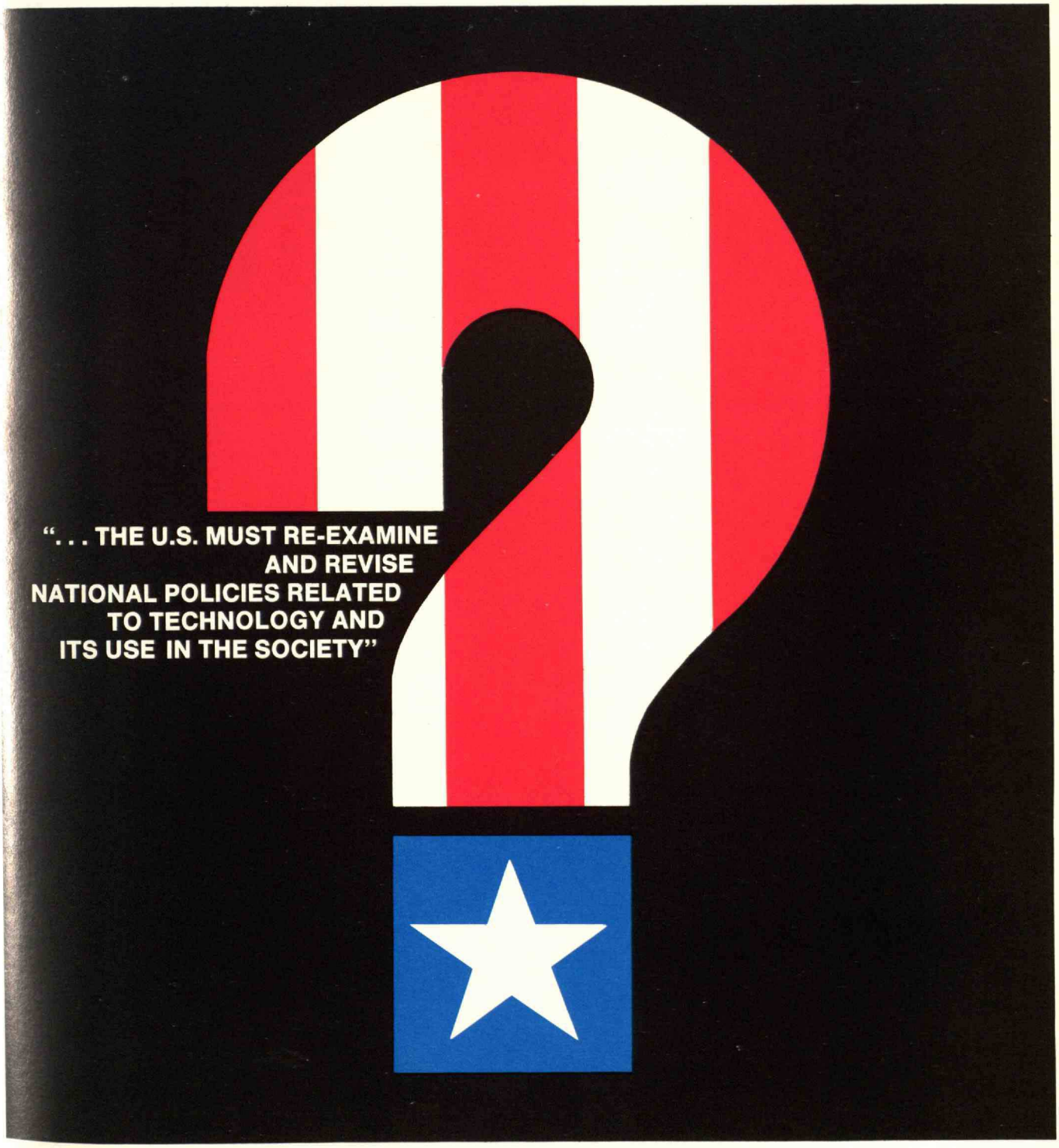
Israel's Water System, by Uri Shamir

Non-Lethal Weapons, by Joseph Coates

Short-Haul Air Transport, by Rene Miller

Edited at the Massachusetts Institute of Technology

Technology Review



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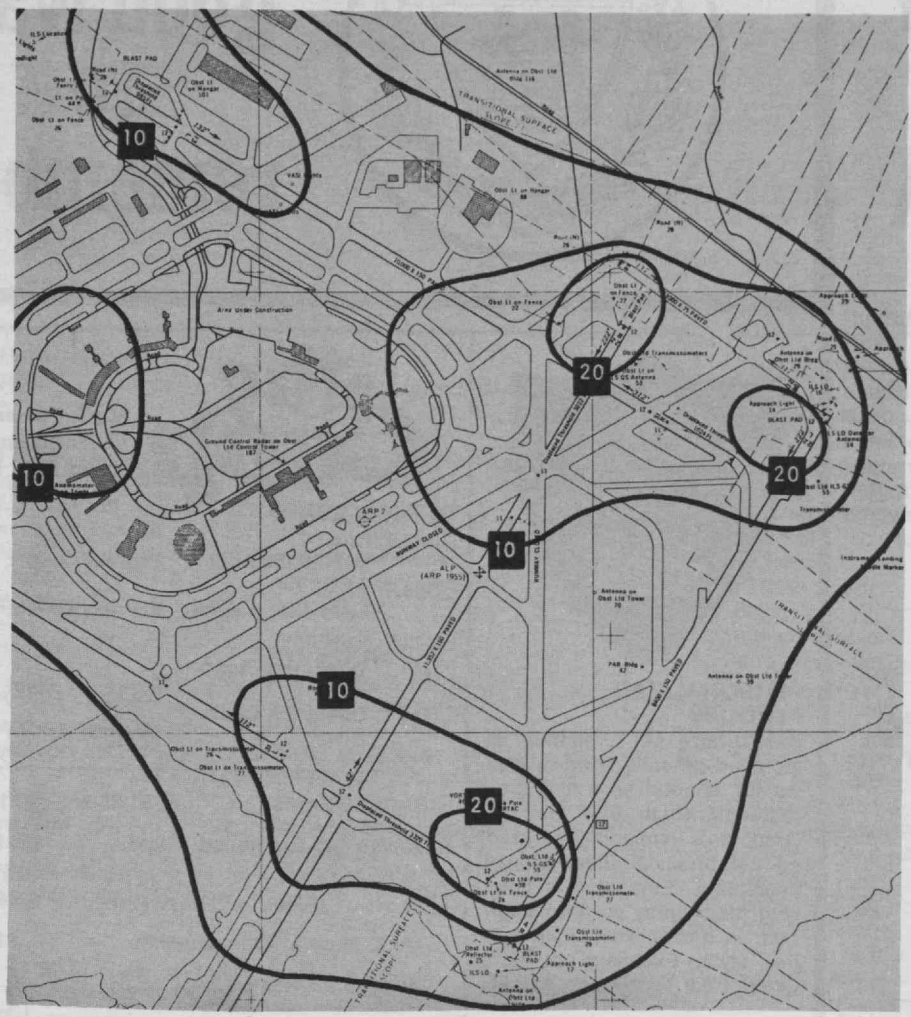

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TR-71

Technology Review

Edited at the
Massachusetts Institute of Technology
Volume 74, Number 7
June, 1972

Articles

Departments

First Line

Questions of Merit

The advent of summer, with its "easier living," brings to mind the situation of those northerners whose desertion of a competitive, aggressive world is complete—achieved by an early retirement or a youthful "cop-out" to tropical places where summer is constant.

These ex-patriots are of two kinds—those who in middle age found urban life too challenging or of little merit, and who have opted for more relaxed—and almost surely less influential—careers in sailboats, inns, and local enterprise. And those in youth who, finding little in their lives promising by standards which they (and not their parents) determine, have opted for an itinerant life of sun and sand in converted delivery vans. These two apparently very different kinds of deserters raise questions about the standards and purposes of our technology-based industrial culture from which they have fled: Is it leading us to goals which matter? Are we really working on the questions that count?

A sub-set of these issues is before every practicing scientist, engineer, or manager: Is he working on fundamentally new and useful products—or simply on the chrome plating which makes a device more desirable but actually more complex and perhaps shorter-lived? Is he contributing to excellence, or to an age of escalating mediocrity?

Young people's disillusion is more likely born of academic frustration—of classes that seemed to be saying too little about things deemed to be important, or saying it badly; of programs geared to some vision of scholarship little related to obvious modern need. It is the nature of young people to be impatient of fundamentals, anxious to proceed to new ideas at levels where uses can be obvious and contributions unique. Can education find a path between essential fundamentals and applications which give life and currency to textbooks?

These questions seem to us to have merit for thoughtful professionals of all ages. They are among the issues which motivate us in selecting and editing the contents of *Technology Review*.—*J.M.*

Man Endangers His World Again: Africa

Science Review:
Robert C. Cowen
Science Editor
Christian Science Monitor

Game park enthusiasts who worry about the fate of East Africa's wildlife have their eyes on the wrong species. Man, himself, may well be the most endangered mammal.

When paleontologist Louis S. B. Leakey said this at the American Association for the Advancement of Science meeting last Christmas, he spoke in the context of world environmental decay. Few in his audience realized how apt his comment is in the narrower context of his East African homeland. You only have to get off the standard minibus, game-park-tour-circuit to appreciate this.

As man encroaches more and more on the wild environment, it's not a transition from the primitive to the modern that's taking place. It's traditional and misguided land use that's spreading. Antelopes, elephants, and lion may be losing ground. But man is the species most in danger of habitat destruction. He is losing the base of natural resources on which the cherished plans East African leaders hold for industrialization critically depend.

Drift along Kenya's Tana River by canoe, and you can't see your hand a few centimeters down in the silt-laden water. True, some of the muck comes from natural erosion. But the slash and burn farming along the banks contributes a large share of needlessly eroded soil.

Stand on the edge of the famous Rift Valley and you'll be lucky indeed to see the hills on the other side. Again, natural sources cause some of the haze. But the smoke columns where new fields are being opened or grassland is burned to create pasturage contribute heavily to the murk. We always could see one or more such columns whenever we could look around a reasonably extensive horizon during a tour in Kenya and Northern Tanzania last March.

Kai Curry-Lindahl, United Nations ecological consultant for Africa sketches the situation starkly. Wherever he goes in Africa, he says, he finds the threat of poor land use. It's especially dangerous in East Africa where the fragile, semi-arid land is exceptionally vulnerable.

Old Farming Practices That Are Bad

Indiscriminate timbering is decimating the East African mountain forests that catch and hold water. Dr. Curry-Lindahl thinks this has reached the point where all remaining such forests now have more economic value as water supply accumulators and regulators than as timber reserves. Reforesting with quick-growing trees is no alternative. Stands of commercial species, such as the eucalyptus many operators favor, are inadequate water managers.

Dr. Curry-Lindahl also deplores the growing use of fire to clear land and stimulate new grass. While fire can be a useful land management tool, he says, "it's 95 per cent bad. It kills soil organisms, let alone doing other damage."

Thoughtless timbering and use of fire have been known in East Africa for centuries. Some ecologists hold them responsible for creating deserts to the north. Nevertheless, they have been a "natural" part of a more or less stable ecological system. Now, with population rising, their accelerating spread presents a new kind of menace. Environmental problems in Europe and America have come largely as a result of industrialization. Our forefathers built this industrial prosperity, in the first place, from a base of more or less intact natural resources. Poor land use so threatens East Africa's resources its people are in danger of acquiring massive environmental problems without the compensating prosperity.

"Bad land use is destroying the remarkable resource background needed for development here," Dr. Curry-Lindahl says, "Deserts and dry savannah continue to encroach. Former perennial water courses now are dry for long periods."

To think of East Africa's environmental challenge largely in terms of animals versus people, as is so often done, is misleading. If he is to prosper here at all, man himself must learn to treat the environment with understanding and respect. And that probably means that both people and animals would prosper. What has been man's role in the established, undeveloped, but stable ecological system? What should his future role be if he is to develop that system beneficially? These are the two most important and neglected questions East African ecologists have to answer.

Rainfall: The Natural Population Control

Tanzania's great Serengeti National Park —which hundreds of thousands of wildebeests, zebras, and antelopes trek through on their now famous migrations —illustrates this point. A handful of scientists working through the Serengeti Research Institute (S.R.I.) have traced at least the general outline of the area's ecology. S.R.I. Director Hugh Lamprey calls it a quite finely tuned ecological system which could easily be set on a course toward rapid deterioration if key species—especially man—began to destroy their habitats.

East Africa's roughly 11-year climatic swing between drought and good rainfall cycles appears to be the basic driving rhythm. (S.R.I. scientists expect this decade to be dry, by the way.) Allowing for many local and yearly variations within this general pattern, Dr. Lamprey says the productivity of basic food plants, such as grass, keeps pace with the rainfall rhythm remarkably well.

The animals, in turn, reflect the ups and downs of the basic vegetative production. Generally, the various species don't tend to compete with one another. Each tends to use a distinctive part of the food supply. Some may even "coopérate" with others, as when wildebeests graze long grass down to a length that pleases gazelles. The basic regulator of the animal populations is the food supply, Dr. Lamprey explains. And that means the long- and short-term climatic variations.

These permit wide population swings: the wildebeest herds grow toward a million individuals and then crash to only a few hundred thousand. Lions and other predators don't appear to have much impact on such variations. Their role seems to be to keep the swings from going too far: for example, by holding down a population peak. No species (again excepting man) expands to the point of habitat destruction or dies out completely. But while predation has this regulator effect, Dr. Lamprey says it's clear that weather or climate—that is, rainfall—is the critical ecological factor.

And Man Apart?

Men were once part of this complex system. Now they have set themselves aside.

They are totally excluded from the Serengeti Park itself, except as visitors. No one knows what changes this is bringing. A minibus-load of excited tourists may ruin a lioness's hunt, scare an ostrich off its nest, or cause a wildebeest to abandon its calf. Without much objective evidence, some observers believe this is causing distress in the Serengeti animal populations and may induce changes in their behavior.

Meanwhile, outside the park, men are extending their settlements with what seems total disregard of the climatic factors Dr. Lamprey judges to be so critical. To take up farming with irrigation through deep wells is a palliative that will not offset the danger of ignorantly tampering with this fragile ecological system.

The growing problem of vehicle tracks within the park hints at the ease with which that system could be damaged.

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These tracks, made by vehicles "going to see the lions," have multiplied by 250 percent since 1969. Dr. Lamprey calls vehicles a major grassland destroyer. Their damage quickly becomes permanent in this delicate ecology. He estimates that the second car to go down a track reduces productivity of that bit of grassland by half. After a few more passes, the scar remains. Dr. Lamprey foresees the need to make visitors stick to established roads. But he admits this would be immensely unpopular.

Ecologists urgently need to understand man's past and presently evolving role here in order to develop intelligent policies for park management and safe development outside the park. This is a politically sensitive matter. Anthropologists to carry out such studies "aren't very welcome here these days," Dr. Lamprey says. He and his colleagues are trying cautiously, but hopefully, to get Tanzania's leaders to wake up to what really is their own urgent need.

Perez Olindo, Kenya's National Parks Director, expresses himself quite frankly on the need for ecological awareness in his own country. He says pressures for more farm land spring from ignorance rather than real agricultural need. Many of his people think in simplistic terms of "destroy the vegetation, put in seed, hope to get fruit." He calls this "the biggest fallacy I know." In Kenya, he explains, "it is a good way to make a desert. The arable lands we now cultivate are not properly used. They are farmed on a subsistence basis."

Finding the Balance Again

President Jomo Kenyatta urges his countrymen to go "back to the land." While it's a slogan one can respect, Mr. Olindo points out that merely sending people back to the land with no knowledge of its capabilities and limits would be disastrous. He sees a need for small agricultural institutes where people can learn to manage land under East African conditions. If they can make the most of farm land already available, he says, farmers should not need to encroach on the game parks or even to destroy all wildland outside of them.

He feels that a balance between sound agriculture—on soil most suited to it—and sound wildlife management probably is the best way to develop East Africa's difficult land. He explains, "Often wildlife makes the best use of the land even when you think of what advanced agriculture might do. Silt-laden river water can be bad for irrigation. It can spread waterborne disease. Such irrigation requires major capital investment. Why go to that extent when wildlife is already earning a good return—second only to coffee in terms of foreign exchange—without such investment?

"It is both the soil and wildlife which we must manage properly. It is a matter of intelligent management and economic returns, not a sentimental conflict of interests between men and animals. This idea is moving ahead. In Africa, we can learn from environmental mistakes of other regions. It is one reason why we can move ahead fast. That is why I am not discouraged in spite of formidable problems national parks here face."

The parks do, indeed, face problems. Mr. Olindo's government wants to convert Kenya's park system from an independent entity to a department of government. This would subject the parks to the central political bureaucracy and, in Mr. Olindo's view, impair their effectiveness. In Tanzania, a local official has allowed settlement of 100 sq. mi. on the Serengeti. At this writing it was unclear whether or not the central government would uphold him.

Hope: Not Making Our Mistakes

Such developments make discouraging headlines. But it would be wrong to let them obscure the thrust of East Africa's larger environmental challenge. Dr. Leakey followed up his designation of man as the most endangered species by noting that men need not accept this status. They have the capacity to understand their danger and do something about it. Just as East Africa seems to dramatize the danger of which Dr. Leakey spoke, so too does it present perhaps the world's most hopeful prospect for transcending it.

Dr. Curry-Lindahl notes that East Africa has time: not much, but enough to meet the challenge it faces. Its leaders are waking up to this. They have a powerful incentive to do so because their own ambitions for industrial development are involved. Dr. Curry-Lindahl says he's cautiously optimistic, for many leaders are listening to sound ecological advice and beginning to follow it.

His comments and those of Mr. Olindo remind me of an incident during the 1971 annual meeting of the British Association for the Advancement of Science. At this point, I don't remember the name of the African concerned but I can never forget his comment. He took part in a panel discussion of technical aid to developing lands. A few white British students disrupted the discussion with anguished protests about "cultural imperialism" following such aid. The African just smiled at them and said quietly: "I can understand your distress. You see the mistakes of the past and despair of the future. In Africa, we see mainly the opportunity to make a better future. So we do not share your despair. We feel a sense of hope."

Attending On Delphi

Washington Report:
Victor Cohn
Science Writer,
Washington Post

The important Washington reaction to the M.I.T.-Meadows Report* has been emotional: the idea that we are racing against time, and losing the race, has sunk more deeply into the political mind.

The headlines of recent weeks add to the sense of unease. "Energy Crisis Looms" . . . "U.S. Energy Use Seen Quadrupling by 1990" . . . "California Pessimistic About Auto Pollution." The people and their political representatives are still voting for energy, but they are doing so with discomfort, as if to ask, "How long before the crash?"

Do not expect an immediate political result from a report. A great summer power blackout would get action. Would the action just be a demand for more power plants and to hell with the environment? Very possibly, but who can say? It is just possible that more people might begin to ask the really proper questions: How much energy do we really need? How should we allocate it? And how can we manufacture it without digging our graves?

The answer to the last question, like the answer to the question, "How do you make love to a porcupine?" can only be: "Very carefully." For the M.I.T. computer modeling group grimly reminded us that human society as we cherish it is doomed unless we halt the endless upward spiraling of industrial and population expansion. With vastly more people and industry, man in a sense may survive, grinding energy out of water and rocks. But only some super-Skinnerian snake oil could make such a grind joyful.

His concern with this problem first got M.I.T.'s Jay Forrester into the doomsday act. He spun out a preliminary set of curves, then put his apprentices to work on the more sophisticated version.

The Oracle Becomes Precise

The result was, first of all, a smashing publicity success. For a technical paper, it got more space in leading newspapers than anything but a sex report. Some critics ascribed this to masterful handling by the New York publisher and its public relations firm. To be sure, good story management and a day of debate at the prestigious Smithsonian Institution didn't hurt. But the attractive ingredients were more basic: a spine-tingling forecast of doom for once given versimilitude by a duo of magic names: computer and M.I.T.

A similar study without the participation of the Great God Computer would have remained buried in the stacks of slick publicity that swamp newspapers daily. A similar study from the University of Ilconsota would have captured a headline or two and that's all. M.I.T. plus computer plus doom equaled story. Almost as Dr. S. Fred Singer, a Meadows critic, said, "The computer is well on its way to becoming the new Delphic oracle. The High Priest has now become a computer specialist at M.I.T."

But the Delphic oracle was always vague. Not so the message from Meadows, which almost nobody liked: nobody ever likes the messenger who brings the bad news.

Specifically, most economists have disdained the conclusion that growth must or can stop. Most economists and social scientists have said, "The study may be well-intentioned, but it just isn't valid." Many physical and biological scientists have tended to reply, "It may not be valid by the economists' rules, but it's where we're going, and we had better wake up."

* The Limits to Growth, Universe Books, New York, N.Y., 1972, $2.95.

The detailed basis for the study—the factual and statistical assumptions and calculations—have in fact not been fully published and examined yet by other scholars. But it is not likely that the critics will be any kinder when all the details are published. In any case, this article is neither a critique nor a review nor even a review of reviews of *Limits to Growth*. The Meadows curves may or may not approximate the path man will take toward Final Destination. However, a great many more people have learned that a Final Destination is possible.

The Real Value: More Have Heard

This is the important political point. As Secretary of Health, Education and Welfare Elliot Richardson said as he stood before the audience considering the study at the Smithsonian, *Limits* seemed "too thoughtful, too thorough, too significant to ignore."

In late March Russell E. Train, chairman of the White House's Council on Environmental Quality, the council forced on the President by a Democratic Congress, referred to the Meadows report in a speech in Los Angeles. And, perhaps the first official of any Administration to do so, he said, "I would like today to call for a national debate on the desirability of growth." He asked for reflection and research on: population size and distribution; the carrying capacity of the earth, and whether we can depend on technology, the market structure and present institutions to allocate its resources and cope with technological and social change; the effects of new technologies; the distribution of income in a "restrained growth" economy.

Mr. Train said: "Long before most of us, the young have identified the quality of life issue as separate and distinct from the quantity issue. Many young people have been saying . . . that another path towards happiness is possible. The question I wish to raise for national debate is whether it may not also be necessary."

A few weeks later Interior Secretary Rogers C. B. Morton told the House Interior Committee, as it considered the energy crisis, that he has asked a task force to look into *Limits* and the accuracy of its projections.

At the same hearings, however, Secretary, Morton, A.E.C. Chairman James Schlesinger, Treasury Secretary John B. Connally and others all testified on the need for more power, fast. On oil and gas, Sec. Connally summed up the dominant Administration position: "Let us get on with this task as quickly as we can. There have been enough delays" —*i.e.,* hang-ups over the environment. "Let us start leasing, exploring, drilling, pipelining, shipping, refining, and using more prudently the resultant clean energy this country needs to keep our people employed, our economy going and our society alive and thriving in a healthy environment."

The "let us start" was of course the heart of his statement, before it trailed off into the politically necessary bows. "Your conclusion is just full of inconsistencies," one representative observed. "We can't have it both ways."

The Usual Question: What Results?

What about *The Limits to Growth?,* asked Arizona Rep. Morris Udall. "No, I don't believe that any amount of (growth) is good," Sec. Connally replied. "There may be a time, it may be right now" when we have to think about slowing down. "I don't know that we need a 342 horsepower automobile engine. . . . I don't see as essential to the life style of Americans using up electricity for toothbrushes or (for women) to shave their legs."

Laughter. Rep. Udall pressed on. What about the recommendations before the same committee of that stern old lecturer, Vice Adm. Hyman Rickover?

Vice Adm. Rickover, as usual, had laid it on the line. One, we should stop exporting coal, enriched uranium, or major energy-consuming services like uranium enrichment for foreign countries. Two, serious consideration must be given to eliminating tax deductions for children beyond number, perhaps, three, with maybe a tax penalty for any children past number four. Three, we should charge large energy-users more, not less, per unit used; tax large, non-productive uses; and *set an upper ceiling of allowable use for commercial and non-commercial uses.* An energy quota!

Four, Mr. Rickover continued, space heating by electricity should be prohibited unless uniquely required, and wasteful uses of energy should be forbidden—*e.g.,* new buildings with sparse and sealed windows, lighted, heated, and cooled by electricity. Five, we should tax autos by weight and engine size and set upper allowable limits. Six, utilities should not be allowed to tax-deduct promotional costs or pass them to consumers.

Seven, we should prohibit air conditioning except where industrially or medically required. And high excise taxes should be placed on high-energy luxuries like clothes driers and the second car.

"I don't think we've reached the point of being quite that drastic," Sec. Connally responded. "I think you can have a serious energy crisis without preventing the birth of little children."

At the same time, he conceded, automakers *could* make less powerful cars and "the American people *could* save an enormous amount of energy just by going around and turning off the lights—President Johnson set an example."

More laughter. But debate has begun.

All right, then, how about making people turn off their lights? Building lighter cars? Are we going to have to legislate? asked Committee Chairman Wayne Aspinall.

"Probably," Mr. Connally said.

Mars: Volcanoes and Rains?

National Report:
Victor K. McElheny
Polaroid Corp.

The Mariner 9 scientific observatory has been working an intellectual revolution in orbit around Mars since last November thirteenth.

A flood of pictures, now being built up into large scale mosaics, shows many signs of massive and recent volcanism, throwing out cones twice as big as the largest counterparts on Earth. This implies considerable melting within Mars, perhaps lasting until the present.

There are also puzzling indications of erosion by water, a substance virtually absent from Mars' atmosphere today. Yet it is possible that water is still exuded slowly from volcanoes and stored either in large reservoirs of permafrost beneath the surface or held in the northern polar icecap which never quite disappears in summer. Scientists are asking if some kind of life-form could adapt to water episodes every 25,000 years or so, when both icecaps could be expected to melt each summer, possibly releasing enough water into the air to allow some to stand on the surface.

Some 7,000 pictures from Mariner 9 are showing that the Martian surface has been shaped by more than the violent winds which can spring up in an atmosphere 200 times thinner than Earth's, and spread a dust storm over the whole planet in a few weeks, and by more than the churning of meteorite impacts.

Learning Also about Earth and Moon

Our ideas about the moon and Earth are changing at the same time.

Both American astronauts and automated Soviet sample-scoopers have landed on and gathered pieces of the moon. Orbiting instruments have made chemical surveys of wide swaths of the lunar surface. The results point to a moon that underwent extensive melting and the formation of a crust when it came together (along with the other planets) about 4.6 billion years ago. Up to about a billion years later, the little planet underwent massive flooding of its surface basins from interior lava pools that had been created by hundreds of millions of years of radioactive melting.

Scientists on Earth have been drilling hundreds of holes in the bottom of the abyssal plains of the oceans, tracing the drift of the "plates" of the Earth's crust over some 200 million years. What they see is a hot planet that is even more dynamic than earlier supposed.

Meanwhile, they can rigorously survey the Earth's atmosphere with a newly-developed microwave radiometer. This instrument can measure temperatures at various levels in the air down to the surface, even through cloud cover, from a polar-orbit satellite.

Just after the first manned landing on the moon three years ago, two Mariner craft whizzed by Mars as close as 2,000 miles away, taking pictures of large regions along the equator and across the south pole and supplementing this with infrared, ultraviolet and radio measurements of the temperature and make-up of both the surface and the atmosphere. We learned that the south polar cap was largely carbon dioxide. The photos revealed an area of chaotic terrain that might have collapsed through evaporation of subsurface permafrost.

The result of sampling and surveying the moon, surveying Mars, and tracing the

The latest methods and areas of concern in management decision making will be surveyed in this commemorative Convocation presented on the occasion of the Sloan School of Management's 20th anniversary. Organized by the School in cooperation with alumni and the M.I.T. Alumni Association and sponsored by a committee of distinguished executives, the Convocation will be held on the M.I.T. campus. Among the topics to be covered are the economy, international business, marketing, production and operations management, finance, management information and control, system dynamics, human factors in management, management science, labor relations, and entrepreneurship as well as the urban crisis, pollution, energy, health-care systems, and mass transportation.

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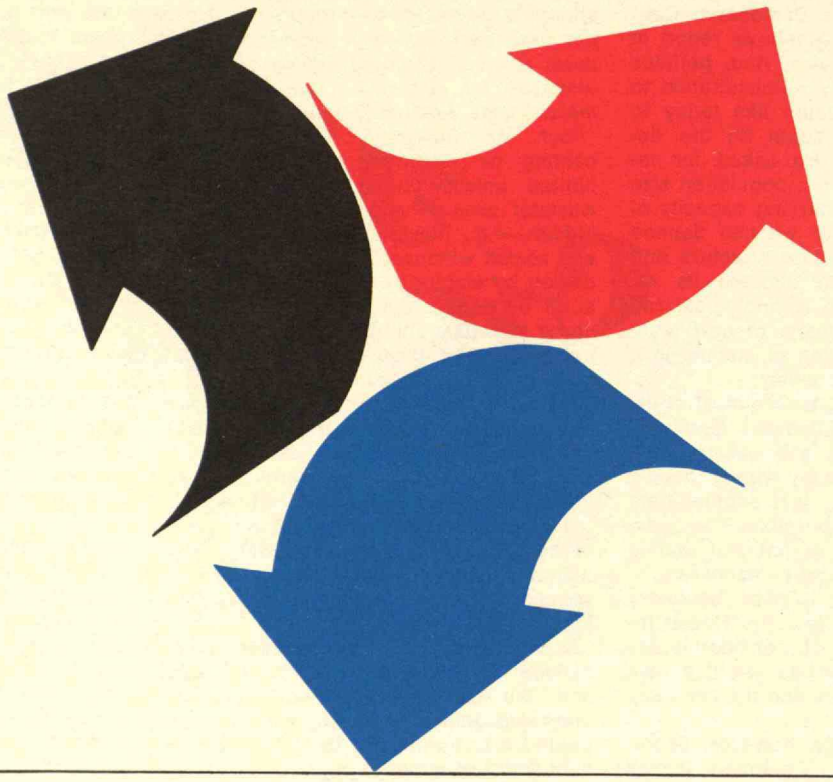

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drift of continents and preparing the way for global atmospheric surveys in depth on Earth has been an almost concurrent intellectual development of a new moon, a new Mars and a new Earth. Scientists can now think about three planetary objects in detail rather than just one. Our concepts of planets in general are enormously enriched—and of the Earth in particular, the only place mankind is likely to be able to live in large numbers.

Comparing the Three Bodies

All three planetary bodies, we find, have experienced long episodes of internal dynamism—melting—in their 4.6 billion year histories.

Instruments left on the moon show traces of a magnetic field that might have been embedded in the rocks through dynamo-churning in a core that once was molten. The pictures of Mars show few meteorite impacts near some of the biggest cones, implying that the huge volcanoes are geologically (areologically?) recent. The measurement of the astoundingly "young" bottom of the Earth's oceans indicates that surface plates are moving with respect to each other at a rate of centimeters per year.

Such discoveries reinforce scientists' ideas of a kind of spectrum of planetary histories, related to their masses, which are roughly related to their sizes. The moon is 2,000 miles across, Mars 4,000 and the Earth 8,000.

On the moon, there is the impression of a titanic era of internal melting; it ended perhaps 3 billion years ago, and was preserved for terrestrial scientists by the absence of air and water.

On Mars, the photos from Mariner suggest a far greater internal dynamism, persisting far longer, than on the moon, but perhaps less intense than that of the Earth.

On Earth, the dynamism is so great that only 200 million years ago all the present continents appear to have been jammed together in one great continent. There are traces of at least two previous couplings and decouplings of continents, covering the past 600 million years of terrestrial history (the period during which all vertebrate life forms have evolved).

An interest in the dynamism of our home planet is more than the idle curiosity of a species whose 2 million year history occupies but an instant in the story of the Earth. One effect of the drifting of plates over the Earth's surface is creation of zones of heavy volcanic and earthquake activity. These lie all around the Pacific Ocean and run through the Near East, the Balkans, and North Africa.

More than a tenth of the world's people live in such zones. Among them are the 100 million people of Japan, the 100 million of Indonesia, the 20 million of California, the 30 million of Iran.

Both the lunar and Martian investigations throw into strong relief the rumbling environment of residents of California, where even a modest earthquake like that in the San Fernando valley on February 9, 1971 (the day Apollo 14 returned to Earth), registering only 6.5 on the Richter scale, can subject buildings to acceleration forces equal to their own weight.

The Opening of Puzzles

Finding so much evidence of volcanism in the pictures from Mariner 9 is puzzling. For one thing, the flow of radio signals back from the observatory shows rigid bumps along the equator. This implies a cool interior for Mars, needed to support the raised regions. Also indicating a cool interior is the apparent absence of a magnetic field around the planet (a finding from the 1965 fly-by mission of Mariner 4).

Yet, there is a huge feature like Nix Olympica—Olympian snow—staring out from a small mosaic of magnificently clear pictures taken about 1,000 miles up. The approach pictures of Mariners 6 and 7 in the summer of 1969 showed this feature to be a 300-mile-wide crater. But from the Mariner 9 close-ups, Nix Olympica is identified as a huge volcanic cone with a collapse-feature, a caldera, at its peak. The caldera alone is 40 miles across. Nix Olympica appears to be at least as elevated above its surroundings, and twice as large, as the volcanoes which thrust 32,000 feet up from the Pacific abyssal plain to form the big island of Hawaii.

Not far away, in the region called Tharsis, lies a string of similar huge calderas. For the time being, they have been labeled North, Middle and South Spot. They are near the classical features Ascraeus Lacus, Pavonis Lacus and Nodus Gordii. Radar surveys by the Massachusetts and California Institutes of Technology show the area to be well above the mean surface of the planet.

There is a difference in the calculations of the height of the Tharsis region derived from the radar surveys and from the gravity survey yielded by the Mariner 9 radio signals. Because of the difference, scientists estimate that Tharsis consists of lighter density material like the continental land-masses on Earth (which float like whipped cream on top of chocolate pudding).

Tharsis is ringed with huge cracks. These hint at an episode of uplifting which "cracked half the planet," in the phrase of Dr. Carl Sagan of Cornell University; he heads the group of scientists who study variable features on the Martian surface.

Perhaps Water on Mars?

One of the cracks is a canyon more than 50 miles wide and 2,500 miles long, apparently deeper than the Grand Canyon. It resembles the great African Rift Valley, which was created by poorly understood motions in the upper mantle pulling apart two "plates" of the Earth's surface.

It is along this canyon that scientists have found some of the arroyo-like valleys that look to have been carved by running water. Although the Martian surface is very dry today, telescope measurements have shown there are traces of water in the atmosphere. Mariner 9's instruments have found water to be relatively more abundant over the South polar cap than elsewhere. Perhaps some of the water in the atmosphere comes from water released by summertime melting of a polar cap.

But such water seems to be lost quickly—perhaps at the rate of 100,000 gallons a day over the whole planet. An infrared spectrometer found water vapor absorption lines in the lower atmosphere, and an ultraviolet spectrometer picked up the signature of oxygen and hydrogen—dissociated by the sun's rays—in the upper air.

Scientists think that some of the water—and carbon dioxide—of the Martian atmosphere might come from still-active volcanoes. Studies of the huge volcanic cones showed white clouds—similar to a "W" cloud frequently spotted by astronomers using telescopes—showing up at the peaks around 3 o'clock in the Martian afternoon.

As things stand now, the south polar cap disappears entirely each southern summer. This happens to coincide with the time that Mars gets closest to the sun on its 687 Earth-day trips around the nearest star. From studying Mariner 9 pictures, the scientists at Jet Propulsion Laboratory in Pasadena, California, know that some areas of the south polar cap clear quite rapidly. Knowing the rate at which the dry ice would "sublime," vaporize, in a carbon dioxide atmosphere 200 times thinner and much colder than Earth's, the scientists deduced that the coating of carbon dioxide on the polar ground must be very thin.

The northern polar cap never entirely vanishes, because it is pointed toward the sun only when Mars is at its aphelion, farthest from the sun, on the planet's elliptical pathway. At aphelion, about 40 per cent less sunlight falls on a given unit square of Martian surface than falls at perihelion (closest point). Earth's situation is similar, but less acute, because the Earth's orbit around the sun is much closer to a true circle.

The north pole is not always in this unhappy condition. There is a "precession of the equinoxes," which takes about 25,000 years, by which the situation is reversed, so that the south pole becomes the cold one and the north pole the warm one.

And Perhaps Life?

Dr. Sagan speculates that this means that Mars is currently in an ice age, with most of its water locked up in the northern icecap. Some 12,000 years from now, sunlight will be falling equally on both poles and most of the water locked in the icecap would be released into the atmosphere. There might be enough of it in the air—perhaps 1,000 times as much—to create a pressure high enough to permit water to exist as a liquid on the surface. Then there would be such things as rain and lakes and rivers and arroyos and canyons.

Dr. Sagan submitted this charming speculation to the planetary science journal, *Icarus,* which he edits, before Mariner went into orbit. He hopes some clever little organisms might remain alive on Mars, by living dormant through Martian ice ages. The creatures would await a supply of liquid water. Then for a brief

(Continued on page 70)

J. Herbert Hollomon
Director, Center for the Study of Policy Alternatives, School of Engineering, M.I.T.

Technology in the United States: Issues for the 1970's

Technology affects the fabric of all human societies. It provides the means for improving the productivity of labor and capital as well as new products that enlarge the options for human endeavor. But we are beginning to understand that use of any particular technology may adversely affect the society as a whole while benefiting those involved directly in its use. Technological change and the new options that derive from new science and new technology alter the values of the society and demand new institutions, new public policies, and new directions for technology itself.

"Science" and "technology" are so often linked that we forget they have different attributes: the technology employed by a society depends markedly on that society's particular cultural and political framework, on its resources, values, and myths; science tends to be less culturally determined, its advances often being known worldwide long before potential technological applications can be developed and assessed.

Although the ways that a particular society or nation uses and controls technology depend on its cultural values, economic development, and political and social organization, the basic nature of technological change and the problems it engenders are similar for all the modern, industrialized nations. The Soviet Union is beginning to be concerned with secondary pollution effects of its industries; Japan has the growing problem of moving new science developed in its universities into industrial use; the United Kingdom is encouraging industrial innovations to stimulate economic growth.

Albeit what is considered valuable in one society is different from that in another, so the balance maintained between social benefits and costs always depends upon the value system of the country. Nevertheless, because technological change is so rapid, its effects so pervasive, and its potential for significant adverse social and environmental effects so large, most of the industrialized nations are now concerned with establishing restraints to keep in balance the positive and negative effects of new technology. Controls on the sale and manufacture of medicinals are such an attempt to achieve a balance between furthering new treatments of disease and protecting patients from potential adverse side effects. The recent regulations to restrict certain effluents are an attempt to preserve the common environment. Such controls are not new; the ban on private privies in cities began in the 19th century.

The support of science and technology for national space and defense programs during the post-war years in the United States and the United Kingdom (and possibly in the Soviet Union) affected the course of developments in basic science and technology. Some useful innovations entered industrial practice as "spin-off" effects—unanticipated new and useful technology applied to non-space, non-military pursuits as by-products of work thought to have military significance. And a large proportion of these nations' scientific and technical manpower was diverted into military and space efforts, bringing increased salaries for scientists and engineers, higher costs for technical work, an expanded market for technicians, and a gradual change in the character and qualifications of the manpower resources in science and engineering.

This military emphasis is now reversing, though there has been little absolute decline in military research and development in the U.S.; in fact, in the proposed 1973 Budget the President has recommended an increase of $900 million for defense research and development. But the proportion of the total U.S. budget assigned to space and defense research and development has decreased—without, as yet, any compensating increase in civilian-oriented research and development by either the federal government or private industry. Thus the demand for highly qualified scientists and engineers has decreased during a period of high general unemployment, slow growth in the G.N.P. and productivity, and serious problems in the balance of trade between the United States and its trading partners.

These converging circumstances—concern for moderating the effects of technology, social need for new technology, and the economic distress of technically-oriented enterprises and their potential employees—have generated renewed interest in a national U.S. policy for science and technology.

Although crucially important, support for science itself is not the pri-

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J. Herbert Hollomon, who has been at M.I.T. since 1970 as Consultant to the Provost and the President, has just been named Visiting Professor of Engineering and Director of a new Center for Policy Alternatives established in the School of Engineering. Following graduation from M.I.T. (S.B. in physics, 1940, Sc.D. in metallurgy, 1946), Dr. Hollomon was, in sequence, Director of Research and Head of the Central Engineering Laboratory for General Electric Co., Assistant Secretary of Commerce for Science and Technology, Undersecretary of Commerce, and President of the University of Oklahoma.

Twenty-five years after the U.S. began an intensive exploration of increasingly sophisticated technology, the nation finds itself confronted by a recession and a weakening position in the world competition which together focus on technology-based industry. This article summarizes the present position; a second, in the next issue, will outline some courses for future action.

mary issue. That questioning, inquisitive, artistic search for knowledge uses but a small fraction of the support for research and development in the United States, even though the proportion of what we may define as science in various fields is affected by social and political values as well as by scientific fads and the structure of the science "establishment." Our central interest now is in *the nature of technological change itself*—the process by which it occurs, the roles of industry and government in supporting certain aspects of this process, its benefits, its costs, and who appropriates the benefits and who bears the costs.

If we are to delineate policy alternatives and evaluate possible changes in government policy, two things are necessary:

☐ We must understand the nature of technological change itself—i.e., the *process* of change.

☐ We must examine the nature of existing public policies and programs that affect technological change both in the United States and in other industrialized nations. Particularly, we must examine our most important resource for technological change—trained scientists and engineers; we must study the role that research and development plays in the private sector and in the technological development of other industrialized nations.

The first part of this paper will discuss these issues, concluding with a summary of where the United States now stands. The second part of this paper, which will appear in the next issue of *Technology Review,* will delineate policy options for technology in the 1970s.

The Nature of Technological Change

In considering the nature of technological change, it is effective to consider the process as developing in three interrelated, but conceptually distinguishable steps: (1) invention (the conception of a new idea); (2) innovation (the first introduction of the idea); and (3) the diffusion of the new technology. This process depends upon certain factors: the "state of the art"; the availability of people knowledgeable in that art and in the use of technology; the presence of people able to anticipate, perceive, and organize the market for a new or improved product, process, or service. New technology is either "pushed" into use by deliberate investment in research on a particular problem—for example, breeder reactor development; or it is "pulled" into use by the expanding demand for a new product or service—for example, air brakes, signal systems, and Diesel-electric power on U.S. railroads, some of them encouraged by investment support offered by the U.S. government. The transfer of new technology occurs largely through the verbal communication and interaction of people. For changes that are aimed at dealing with social problems, such as pollution or crime, the market is controlled by social processes, including legislation or regulation—often based on changes in the values of the society—as well as by such economic processes as consumer demand and industrial competition. To stimulate changes in industry in a market economy, the role of the federal government is to establish conditions that encourage or stimulate invention, innovation, and diffusion of change, and to ameliorate the adverse societal effects of change which usually act to discourage its introduction.

Changes through which a new product or service substitutes for an existing one or provides capabilities for doing something new often cause substantial and unanticipated changes in the society: workers are displaced, economies of entire regions are changed, secondary ecological effects are found to occur. Widescale adjustments are required; and if they do not occur the political climate is likely to be altered to resist further change.

As the United States has become more populated and society more interdependent, the indirect social cost of technical change has increased relative to the direct cost assignable to innovation, research and development, and implementation. Indeed, the social cost sometimes outweighs the private benefits. The major difficulty occurs because private costs and benefits are easy to identify—at least in a relatively free market economy—while social costs and benefits tend to be intangible and difficult to allocate. The private benefit is assessed within the transactions of the marketplace, while the social benefit must be assessed and the methods of ameliorating or allocating social costs determined through the political process.

To meet national needs for those public services of which the society is the primary purchaser, government encourages invention, innovation, and diffusion; provides support for the basic technology that underlies specific, national objectives; and in some instances creates a market for products or services to meet a collective need. For example, for defense needs the national government supports the technology and purchases the necessary equipment. For the improvement of the educational system, the federal government has recently begun to support

research and development; by changing educational standards and institutions, it is providing a market for new education-oriented products and services.

The balance between services supplied privately and those supplied by the government varies in Western societies. In the United States the role of private industry is to produce most of the goods and services required by the society, within the constraints and support of general public policy; in some other countries national responsibilities extend into production and distribution. Governments support technical activities to improve the services supplied by them, support activities to provide technical resources including scientists and engineers required for innovative activity, and support activities to encourage technological change in industry, education, agriculture, and government. More recently, governments have undertaken a new role with respect to technology, by acting to ameliorate or avoid adverse social consequences of technological change, whether they arise from public or private activities.

	Federal expenditures for non-health, non-aviation civilian research and development	
Period	*Increase (Millions of dollars)*	*Percentage increase*
1972/1971	$264	+15.1
1971/1970	237	+15.7
1970/1969	21	+ 1.4
1969/1968	199	+15.4
1968/1967	151	+13.3
1967/1966	−35	− 3.0
1966/1965	244	+26.2
1965/1964	198	+27.0
1964/1963	−159	−17.8
1963/1962	140	+18.6
1962/1961	129	+20.7
1972/1961 (average)	$126	+12.1%

The author points out that government support for non-health, non-aviation, non-defense research has grown "at a surprising rate" in the decade of the 1960s. The table shows the rate of growth of federal expenditures for civilian research and development since 1961.

U.S. Policies Affecting Technology

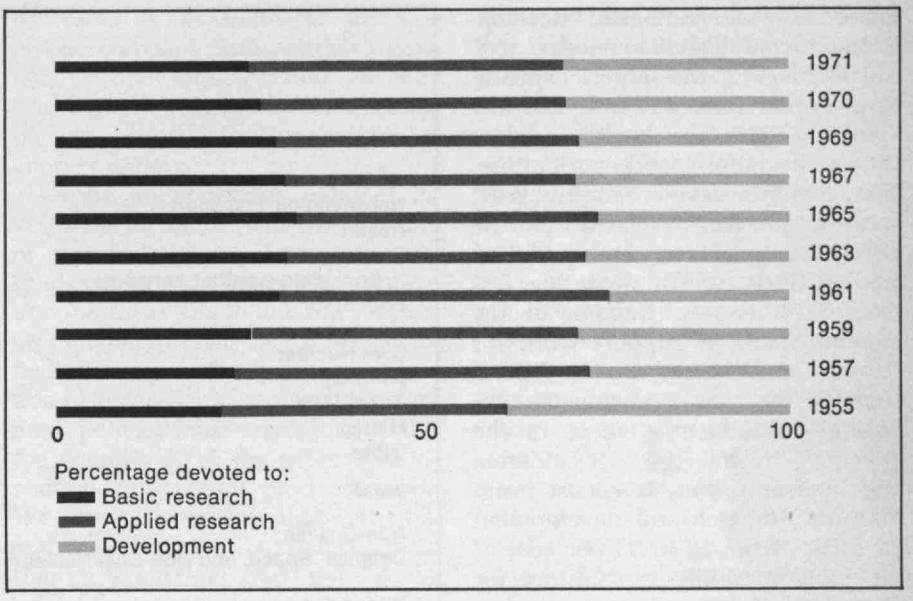
U.S. public policy affects technology directly and indirectly, and an understanding of the role played by public policy in affecting technology is central to understanding the nature and direction of technological development in the United States.

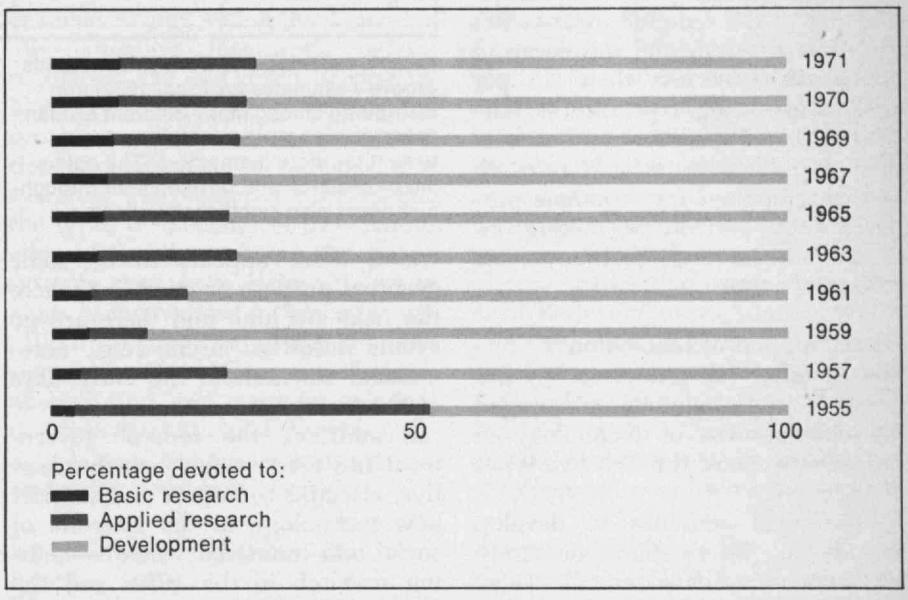
The U.S. government gives direct support to basic research in the sciences primarily by offering research grants to universities and stipends to students studying in fields expected to be important in meeting national needs. Since 1953 national priorities have been reflected in large federal support for activities underlying space exploration, national defense, and the attack on disease. Although still relatively small, support for other, civilian-oriented activities connected mostly with rapidly growing social problems has grown at a surprising rate in the past ten years.

The composition of federal research and development support also affects the direction of technological development. In spite of the growth in civilian-oriented research and development, the fraction of the G.N.P. devoted to research and development in the U.S. has declined since 1967. The character of government-supported civilian research and development is different from that of military and space work. Basic research comprises 27 per cent and development 31 per cent of all U.S.-sponsored civilian (non-space, non-defense) research and development; but in government-sponsored space and defense work, basic research comprises 9.7 per cent and development 73 per cent.

Costs for development—i.e., bringing the results of research to practical application—are always much larger than those of the research that produced the innovative opportunities. The present balance of support between basic research and development for civilian-oriented activities emphasizes basic research. As long as it persists the federal support process is unlikely to produce

An understanding of the role played by public policy in affecting technology is central to understanding the nature and direction of technological development in the United States.





Basic research is a substantial part of the total non-military research and development of the federal government (below) and a much smaller part of the federal military research and development effort (above). The relationship between basic research, applied research, and development in the U.S. military program is also typical of that reported by successful U.S. industries who make major research and development investments. As long as the civilian effort does not provide for large development support says the author, it is "unlikely to produce major new technological developments related to civilian needs."

major new technological developments related to civilian needs.

In fiscal 1972, the largest expenditures for civilian research and development are for health, nuclear energy, aviation, and agriculture. The amounts devoted to the great societal problems related to the cities, transportation, and pollution are relatively small, altogether less than $1 billion—a fraction of the amount spent to support work for defense and space. Direct federal support for new technologies important to industry, except in the advanced technologies of aviation and nuclear power, is almost insignificant. Research and development comprises from 18 to 22 per cent of the total operating expenditure for space and defense; but for the remainder of the federal government's activities research and development are consistently less than 2.5 per cent of operating expenditures. The United States spends a smaller fraction of publicly supported research and development for economic purposes (e.g., agriculture, mining, industry, and services) than any other industrial nation.

	Federal research and development	
Area and Field	*Amount (Millions of dollars)*	*Percentage*
Civilian:		
Non-Aviation Transport	$ 200	1.3
Health	1,286	8.2
Environment (Including weather services)	784	5.0
Education	191	1.2
Housing	25	0.2
Civil Nuclear	626	4.0
Aviation	343	2.2
Agriculture	314	2.0
Mining	135	0.9
Other	293	1.9
Total	$ 4,197	26.8%
Non-Civilian:		
Defense, Space, and Non-Civil Nuclear	$11,469	73.2%
Grand Total	$15,666	100.0%

Federal research and development funds (above—estimates for fiscal 1972) are distributed among many different civilian fields; some activities and industries benefit far more than others. The obtaining of research and development through purchases also significantly affects the effective level of research and development in various industries. In the past, studies to correlate research and development with industry performance have not taken into account this "purchased" research and development.

Direct Support of Innovation

Historically, U.S. federal policy has directly supported and encouraged the development of technology in the private sector through five types of activities:

☐ Technical activities to develop the basic information necessary for economic development (e.g., mapping and charting; basic behavior of materials).

☐ Direct support of new technology in applications where the size of the economic unit is small (e.g., support for agricultural technology).

☐ Direct support of research and development on new technology where there appears to be some eventual purpose or need but where the risks are high and there are no extant industrial users (e.g., aeronautical research in the early days of N.A.C.A.).

In addition, the federal government has made a few, mostly abortive, attempts to initiate and support new technology in the interests of social and industrial welfare—housing research in the 1950s and the State Technical Services Act in the 1960s.

With these few exceptions, and with the exception of the "spin-off" technology from space and defense work that has found application to non-defense-related needs, the heavy concentration of federal support for the sciences and technologies that include defense, space exploration, and the conquest of disease have diverted resources from activities directed at meeting other widely recognized social and technical needs.

Indirect Incentives for Innovation

Excluding the patent system, the federal government has no program that directly encourages invention. And the strength of the patent system is focussed in the provision of a monopoly that encourages innovation rather than invention, for the patent monopoly permits the innovator to capture a larger share of the benefits of innovation than would be possible otherwise and thus en-

The emphasis in the U.S. between 1950 and 1970 on new technology and advances in science rather than on the application of existing knowledge affected the nature of technological development in a complex way.

courages him to take the initial risk. There is no government incentive for the application of innovations by an inventive industry.

The federal government has wielded its greatest influence on the direction of technological development by its purchases of high-technology items important to defense and space, thereby decreasing both the developmental cost and the market risk of these products by guaranteeing purchases. Examples include the development of commercial aircraft assisted by the purchase of their military counterparts and the development of large, high-speed computers first designed to meet government requirements. The direct support of nuclear technology by the Atomic Energy Commission and government sponsorship of the supersonic transport are examples of programs aimed at assisting in cases where the risks, as assessed by the polity, were high compared to the assets and capabilities of industrial firms.

Indirectly, too, the emphasis in the United States during the period from 1950 to about 1970 on new technology and advances in science rather than on the application of existing knowledge affected the nature of technological development in a complex way. This emphasis on new technology was natural, since advances in space, defense, and the conquest of disease—three national priorities—were limited primarily by technical or physical capabilities. However, a considerable number of studies indicate that even during this period the majority of the innovations that significantly affected the nation were stimulated by the market rather than by new technology or science, where the emphasis supposedly lay. Most were related to processes of invasion—the invasion of one company into another's market, of one industry into an area traditionally covered by another, or of one nation into the markets of another nation.

Despite an enormous national investment for more than two decades in the technology of defense and space exploration, ingenious application of ideas involving old science predominated. This fact makes compelling our premise that any evaluation of federal research and development policies must take into account the complexity of the process of invention, innovation, and diffusion. We must recognize that research and development activities, even though profitable, may not be the primary source for technological or social change within the society.

By affecting incentives, federal regulatory tax and antitrust policies have also indirectly affected the processes of technological innovation and diffusion in industry. For example, the regulations that define the types of mechanical connections allowed in the nation's telephone systems may have delayed certain kinds of innovations in telecommunications; regulations of the Federal Communications Commission have affected and will continue to affect the direction of cable television technology and the rate of return on investments in cable telecasting.

Unproductive Indirect Federal Effects

The most important indirect effect of our current federal policies, and one of growing concern to any consideration of future policy alternatives, is the displacement of workers. Displacement is a significant factor that influences and is influenced by technological change. Workers are displaced either by new processes that require new skills or fewer employees, or by new (or cheaper) products that invade the markets of established firms or industries.

Pressures arising from these displacements are felt in many ways. Labor unions devote considerable attention to job security and to work rules to prevent or ameliorate displacement, particularly in industries that are not growing rapidly. Firms delay or reject innovations because they anticipate resistance or large retraining costs. In general, displacement adjustments are more easily made in growing than in stagnant industries; only in some firms in rapidly changing industries is continuous retraining to develop new skills considered part of the normal cost of doing business.

Who should appropriately bear the cost of displacement or retraining? Presently, in the United States, the burden frequently falls on the worker left to fend for himself. Sometimes, when whole industries or large numbers of people are involved, the public supports displaced workers. Examples are the Area Redevelopment Administration Program (now E.D.A.), a regional development program to revitalize a whole region—Appalachia—affected by great changes in the productivity of coal mining and the replacement of coal by oil and the aid to firms and workers displaced by imports provided in the U.S. Trade Expansion Act of 1962.

Displacement assistance has been used very little in the United States in contrast to many other industrialized nations. While the training of youth in secondary schools, vocational schools, colleges, and universities is generally accepted as a public responsibility in the United

States, there is little broad support for educating or retraining adults, either those who have been displaced or those deprived of an earlier educational opportunity.

Technology Incentives in Other Industrialized Countries

Almost all the other industrialized countries have also formulated policies and developed programs to stimulate innovation and the diffusion of technology to meet national needs. The mechanisms and procedures utilized by each vary enormously because of economic, political, and cultural conditions; but a number of characteristic program types can be defined, among them the following:

Tax Incentives for Private Research and Development. Canada and Japan provide examples of special tax treatment programs that are intended to stimulate research and development in the industrial and service sectors of the economy. In Canada, firms may deduct their entire current research and development expenditure and 50 per cent of the amount by which this expenditure exceeds some predetermined reference level. Japanese tax regulations allow a 95-per-cent depreciation on experimental research equipment and a 33-per-cent depreciation on equipment purchased for development purposes in the first year. Japan also permits 20 per cent of the expenses incurred in technical assistance programs to be treated as losses for tax purposes.

Direct Support for Industrial Technology. Several countries provide financial support for activities aimed at improving general industrial technology. Japan's Agency for Industrial Science and Technology subsidizes through grants-in-aid applied research, experiments on new industrial processes, and the manufacture of pilot models. Under its Industrial Research and Development Incentives Act Canada supplies grants for 25 per cent of the annual capital expenditures on completed research and development projects and 25 per cent of the amount by which current research and development expenditures exceed average expenditures of the previous five years. France's General Delegation for Scientific and Technical Research provides matching funds for research and development considered potentially profitable or in the national interest.

Encouragement of Invention. In Japan, the Invention Encouragement Council subsidizes inventors through grants for the full costs of experimentation, including equipment. The West German Fraunhofer Society offers legal advice and financial assistance for the initial development of new inventions and is nearly self-sustaining.

Direct Support for Industrial Development Activities. The United Kingdom's National Research Development Corporation functions to develop and exploit inventions resulting from research in government institutes or private inventions deemed to be in the public interest.

Industrial Research Sponsorship. Industrial research associations and industrial research institutes undertaking research of benefit to an entire industry are partially government-supported in almost every Western European country. Government contributions range from 2 per cent in France to 50 per cent in Italy and the Netherlands. Most of these associations obtain government support through contracts or grants, and they often perform confidential contract research for individual member firms.

Joint Government-Industry-University Laboratories. The Max Planck Institutes in West Germany represent a unique method of supporting technology and science. More than 60 institutes which engage primarily in research and development are jointly supported by the federal government and the Lander (states), by industry, and by private contributions. Individual institutes focus their activities on single areas or disciplines and are often associated with nearby universities. An institute's research staff generally includes university faculty; graduate students can receive academic credit for research they perform within the institutes.

Diffusion of Technology. The Organization for Industrial Research in the Netherlands focuses most of its activity on the diffusion into industry of exploitable technology deemed to be in the public good. Special emphasis is placed on development and investment grants to small and medium-sized firms.

Capital for Industrial Development. The Japan Development Bank provides loans to industry to assist in financing new or high-risk technologies.

Training for Workers. Great Britain's Industrial Training Act of 1964 provides a valuable mechanism for retraining workers. Most industries have Industrial Training Boards

Excluding the patent system, the U.S. government has no program that directly encourages invention. But almost all other industrialized countries have formulated policies to stimulate innovation and the diffusion of technology.

composed of labor, industry, and educational representatives, which can impose levies on employers. The money collected is disbursed through grants to provide retraining courses and pay subsistence and travel allowances for employees within the industry. The Swedish government, which operates an employment service used by 25 per cent of all job hunters, promotes mobility by giving full assistance for travel, moving, starting, and settlement costs. If necessary, the government buys vacated houses and encourages new housing for relocated workers. Sweden also offers retraining courses of from two to 20 months open to all citizens and provides living allowances for displaced workers up to two-thirds of a worker's previous salary. Either through direct courses or by direct subsidies to industry, the government retrains 1 per cent of the Swedish work force each year.

Social and cultural differences as well as differences in industrial practice in the various industrialized nations have substantial effects on the innovative process. Japan's higher rate of saving, for example, makes proportionally greater amounts of capital available for investment in new plant and equipment than are available in the United States. Regulations in West Germany are far more lenient toward joint industrial development efforts than those of the United States.

In fact, the majority of the world's highly developed nations give more intensive attention and support than does the United States to the means by which technology is applied to the society and to activities which cannot be appropriated by a single firm. Special programs to this end have not been considered necessary in the U.S., but new and growing problems created by complex technological and social interrelationships, such as job displacement and environmental pollutants, will make them essential in the future. How much we can learn and adapt from other countries' experience is hard to judge because their exists no thorough, comparative evaluation of policies used elesewhere.

U.S. Supply and Demand for Scientists and Engineers

The most important single resource to effect technological change is trained scientists and engineers capable of translating knowledge into use. This is true whether new techniques are to derive from new science, from new technological capabilities, or from old technology applied to a new set of circumstances.

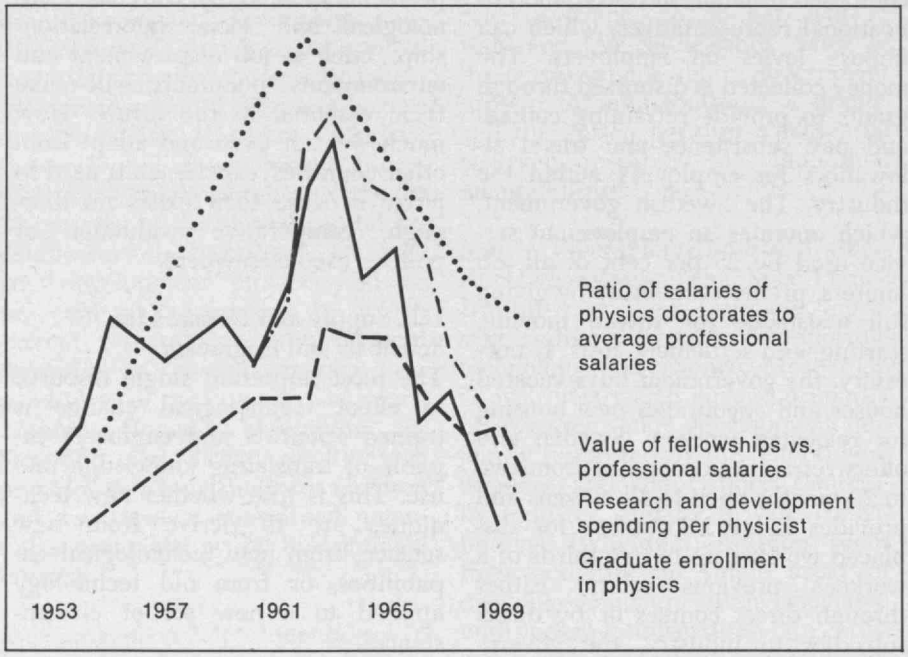
The demand for scientists and engineers in the U.S. during the last 25 years has been conditioned chiefly by the large, fluctuating federal programs for research and development. We have previously published in this journal an analysis of the interrelationship between the manpower demands of military research and development in the 1950s and 1960s and the nation's industrial research and development resources and costs (*see "America's Technological Dilemma" in* Technology Review *for July/August, 1971, pp. 30-40*). Our conclusion was that manpower resources now available in the U.S. are depleted in quality and inflated in price due to the competition for research and development to fulfill expanded government programs during that period.

In 1966 federal support of research and development began to decline; a bit later, graduate stipend support was reduced; in 1969 an economic recession set in. The demand for scientists and engineers, so long maintained by growing government programs, began to decline. At the same time, industry generally was reducing its costs to coincide with the decline in private demand for goods and services. These factors in combination resulted in the significant unemployment of scientists and engineers which is now familiar to all.

That the supply of scientists and engineers—in fact, of almost all trained people—responds to market forces was a lesson most poignantly learned during the recent cuts in space and defense funding, which left tens of thousands of highly skilled technicians and scientists unemployed. In general terms, the number of people who opt for training in a given field depends upon the choices open to them at the time they begin training and their perception of rewards offered by a career in a particular field. Accordingly, as Richard Freeman has shown, in the last several years fewer students have chosen to enter graduate school in the physical sciences, particularly physics. The decline in relative demand for engineers with bachelor's degrees, which began a few years earlier, is reflected in a corresponding decline in the number of freshmen entering engineering programs. Since training takes time, the effects of changing market conditions are not immediately reflected in the supply of trained people; our decreasing science and engineering enrollments will lead to a decline in the supply of some types of scientists and engineers in the mid-1970s.

There is also a subtle influence of past policies on the training and experience of scientists and engineers.

Past support for research and development was responsive to certain national goals, and the training scientists and engineers received was naturally related to serving those goals. However, talents learned then may not be the ones most useful to the development of industrial technology or to the definition of current technological and social problems. Indeed, for 20 years the training of scientists and engineers has been oriented toward technically sophisticated areas, away from problems of technology related to improving productivity and to the public market for education and health services. Industrial—or manufacturing—engineering is not taught today in most technical schools. If we wish now to apply our resources to different problems and needs, the science and engineering education we offer in the universities must change.



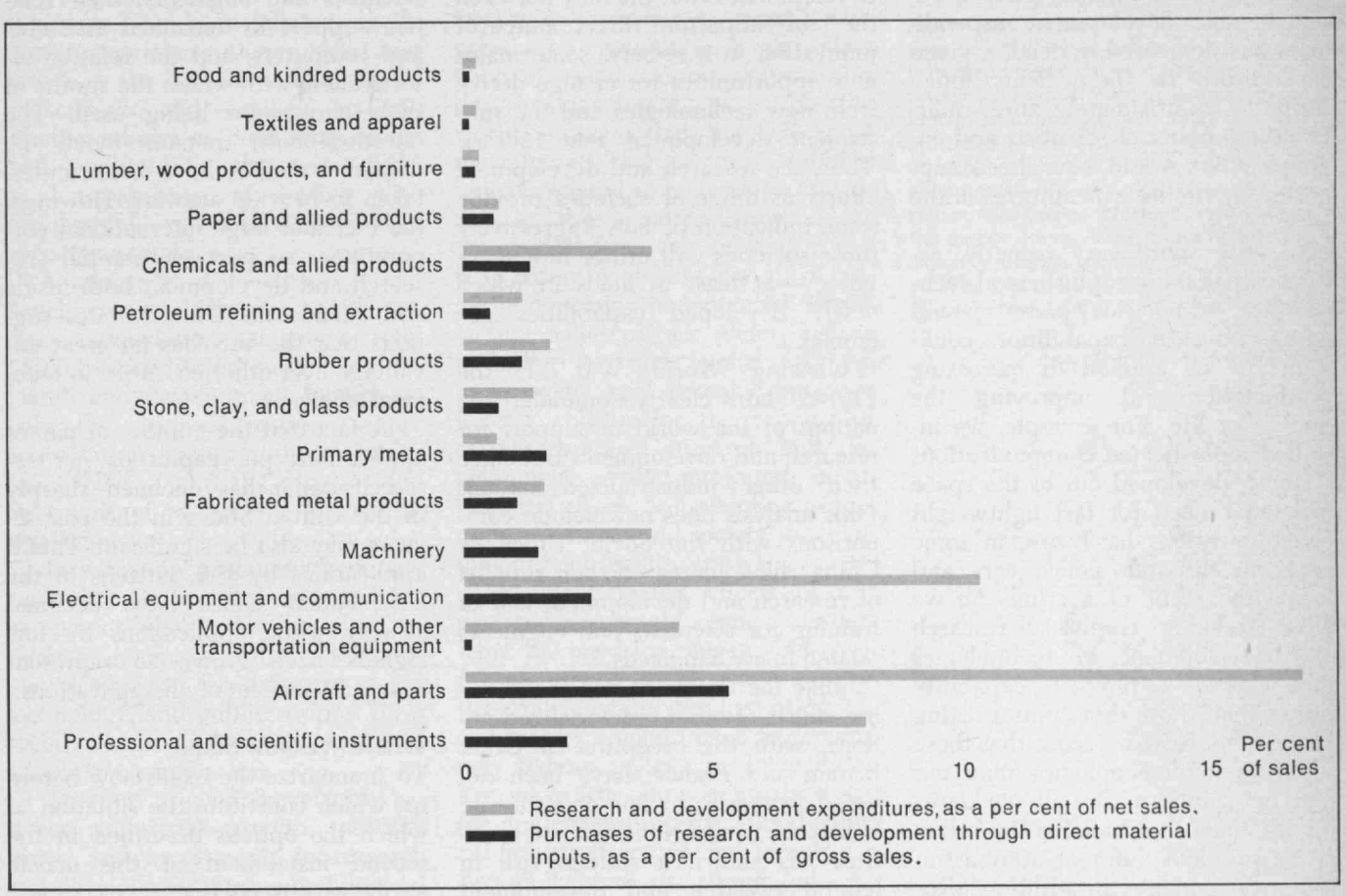
Graduate enrollments are exquisitely responsive to the economic situation of the professions. This chart shows that—with a two-year time delay—graduate enrollment in physics dropped almost exactly as the demand for physicists dropped, the latter as measured by the salaries offered to new graduates in that field. Other indicators of prosperity were in turn responsive to enrollment—the value of fellowships and the amount of research expenditures.

Industrial Technology in the U.S.

The function of applied research and development is usually to discover radically new technology based on new technical possibilities derived from scientific research, not to promote old or modified techniques even if related to new applications. But by this definition very little of the improvement in industrial technology in the U.S. before 1900 sprang from U.S. applied research and development. Indeed, little or no research and development took place in the United States prior to the early 1900s. New industries were created, new techniques introduced, new skills learned, new products brought to market, and the scale of manufacturing and productivity increased; but many of those improvements were results of technology developed in Europe newly applied to a situation in the U.S.

A great deal of the industrial improvement in this country may still take place by the diffusion for different purposes of techniques already highly developed or by innovation based upon existing technology. In some industries technological improvements are the results of work performed only in related industries. The nation's railroads are an example: railroads traditionally do very little research and development; reductions in freight costs over the years have resulted indirectly through the purchase of equipment from industries that do engage in research and development. Another example is the U.S. electric power-producing industry, which traditionally has not performed much internal research and development. The real cost of electric energy has been decreasing for decades, largely through inventions and innovations the industry acquired in equipment bought from electrical manufacturing companies.

The opportunities for applying new technology vary enormously from industry to industry, and ways of improving efficiency differ from firm to firm. Technological developments outside an industry may result in new opportunities for a firm which



Technological innovations in an industry need not depend solely upon that industry's expenditures for research and development; Richard Freeman has shown that many industries rely heavily upon purchasing new innovations in the form of direct material inputs—new equipment and methods devised by suppliers' research and development effort.

had no responsibility for the original work. But whatever the method of technological change in industry, all change has one thing in common: It requires capital for new equipment, training, and adjustment. These expenses are seldom considered in enumerating research and development costs, yet the ability to pay them directly affects the rate of innovation.

Clearly a growing industry has greater opportunity to use the results of new technology than a stagnant or declining industry, and there exists a positive correlation between profitability and growth for most firms and industries in the U.S. But William N. Leonard has shown that the correlations between profitability and growth are less good if the electronics and aircraft industries are included in the correlation. His results may mean that research and development is significantly less profitable in industries in which it is largely federally financed than in industries where non-defense market forces control the expenditures.

Taking into consideration these diverse and complicated factors, economists have attempted to understand the relative profitability of research and development. Richard B. Freeman, seeking to summarize the results of all major recent studies of this question, concluded that while the private benefits of research and development are positive, they have often been overstated; these investments appear to be about as profitable as equal investments in capital.

These conclusions indicate that those who support research and development do so sensibly; the returns on investments in research and development are nearly equivalent to the returns on capital. But what about the present and future, as the cost of research and development—and in fact the cost of all technical work in the United States—has been inflated even in relation to the economy generally by the huge increase in federally supported research and development of the 1950s and the early 1960s? The effectiveness—the technical effort per dollar—both public and of private research and development expenditures has decreased; indeed, a given expenditure in these fields today supports approximately three-quarters the number of scientists and engineers that would have been supported by similar expenditures in the early 1950s.

We have, until very recently, assumed that those sophisticated technologies which we know extend man's physical capabilities could somehow be applied to increasing productivity and improving the quality of life. For example, we installed sophisticated communications systems, developed out of the space program's need for fast lightweight communications hardware, in some cities to dispatch police cars and locate the scene of a crime. So we have tended to emphasize research and development in technologies that extend a physical capability rather than those that apply existing knowledge. Now we sense that these sophisticated technologies may not hold out solutions after all; we know, for instance, that to solve the urban crime problem different administrative arrangements, in addition to or rather than new hardware, are needed.

Yet today there remains little support for those complex but mundane activities that underlie the improvement of industrial technology and the delivery of services. Even though half of all U.S. workers are engaged in providing services, little research and development effort has been devoted to improving the provision of services, except indirectly through the purchase of such products as computers and other high-technology office equipment. The productivity of the services sector has increased little.

Too, relatively little technical support is devoted to meeting the major social problems associated with the harmful consequences of previously applied technology. For example, in 1971 only about $720 million out of the total federal research and development expenditure of $15 billion was allocated for work related to the environment (and this includes at least $200 million of ordinary weather services), and significantly less for research toward improving transportation safety.

International Comparisons

While it is clear that research and development is not the only nor even the most important direct source of innovation in a society, some major new opportunities for change derive from new technologies and the subsequent development that follows. Thus, the research and development efforts of different societies provide some indication of how aggressively those societies will utilize new technology—at least in fields in which newly developed capabilities are crucial.

Following World War II, the United States clearly dominated the nations of the world in support for research and development. But since then other industrialized nations (this analysis does not include comparisons with the Soviet Union or China) have increased their support of research and development and of training for scientists and engineers related to civilian needs.

Unlike the United States, the growing efforts of other industrialized nations, with the exception of Great Britain and France, have been devoted primarily to non-defense and non-space needs. None of these countries has shown a sudden rise in federal research and development support such as occurred between 1953 and 1960 in the United States, a rise related largely to the cold war and the "war on disease." Nor has there been in other countries of the Western world the sudden rise in demand for scientists and engineers and the sudden rise in their salaries which has occurred here.

Michael Boretsky has reported that by 1962 the number of scientists and engineers engaged in non-defense, non-space research and development in eight European countries—the United Kingdom, France, West Germany, Italy, the Netherlands, Belgium, Norway, and Sweden—exceeded the number engaged in similar activity in the United States. The number in Japan, with less than 25 per cent of the G.N.P. and less than 50 per cent of the population of the United States, was at least 70 per cent that of the United States, even in 1962.

A significant factor in the ability of these countries to support a larger research and development effort is the relatively higher price paid for scientists and engineers in the United States. It can be argued that such a basic analysis does not take into account possible differences in the productivity of U.S. and foreign scientists and engineers, their relative support by technical assistants and computers, and the relative effectiveness with which the results of their efforts are being used. The question must remain moot; no definitive studies have been undertaken to provide answers. However, the fact that large international corporations support substantial research and development both inside and outside the United States suggests that the U.S. has no great advantage over other countries in technical efficiency.

The fact that the number of patent applications per capita or per research dollar has declined sharply in the United States in the past 20 years may also be significant. Patent applications by U.S. citizens to the U.S. Patent Office have declined sharply while applications by foreigners have grown to represent nearly 50 per cent of all applications.

Where We Now Stand

To summarize the issues now before us, which constitute the situation to which the options described in the second installment of this article apply, we observe that:

☐ The economy of the United States has evolved from agricultural to industrial to service-based. Past improvements in productivity have come largely from the agricultural and manufacturing sectors.

☐ The growing and widespread social consequences of industrial activity and the use of certain products have only recently begun to receive significant technical attention or government action and must be considered in the future industrial development of the society.

☐ As technology has spread throughout the world, competition from overseas is now high and can be expected to continue. The growth

of the Common Market in Europe and the World Market for Japan gives to each of these economic units many of the advantages that the United States has enjoyed uniquely in the past.

☐ The system for educating scientists and engineers in the U.S. has been geared to meeting an ever-growing demand, largely based on the growth of space and defense programs. Recent decreases in their support has led to unemployment and declining salaries and will continue to do so unless other actions are taken.

☐ The prices paid for scientists and engineers have been inflated significantly more than other salaries and wages in the economy. The cost of all scientific and technical activity, whether aimed at increasing industrial productivity, improving technical capabilities, or dealing with social problems, has increased out of proportion to other costs.

☐ While support for research and development to improve health services and aviation has grown, total public expenditures supporting research and development for education, the criminal justice system, non-aviation transportation, health care delivery, and the disposal and treatment of waste are almost insignificant.

☐ Increases in productivity do not come directly from research and development alone; they involve experience in manufacturing, the supply of services, the diffusion of old technology, and public support for a social climate that encourages and adapts to change.

☐ There is a good correlation between industrial growth, productivity, and investments in research and development for many industrial activities; the correlation is less good for the electronics and aviation industries, which thus may be less effective in exploiting research and development than other industries that received less governmental support.

☐ Second-order indirect social costs of technological change have seldom been considered in the calculus of its costs and benefits.

☐ Recent studies indicate that research and development expenditures correlate positively with profitability, but the correlation is much less certain than indicated in studies made in the early 1960's; the profitability of research and development may have declined.

☐ Large investments in research and development are typical of growing industries and may contribute to their growth and profitability. Less dynamic and older industries support relatively less research and development, and this may further depress their growth.

☐ The primary processes of technical change, at least in relation to civil activities, may depend less on new research and development than on ingenious applications of old techniques in response to market demands.

These considerations, as well as the important problems associated with population growth and the slow pace of economic development in the less-developed parts of the world, indicate that the U.S. must re-examine and revise national policies related to technology and its use in the society. However—as seems clear from this analysis of our past federal policies—we must better understand the potential effects of that policy on our society before initiating any new policy. As we have seen, our recent, dominant federal policies for the support of certain types of research and development created profound, unanticipated effects on numerous sectors of the economy and society to which they did not directly apply.

The unanticipated effects of our past policies would seem to underscore the need for caution and careful analysis of future policy alternatives even while our important social problems would seem to demand new federal policies to solve them. Yet very little support exists today for understanding the social-political-industrial system and how it can be moderated or stimulated. Although techniques are now available for analysis and stimulation that would permit such studies, little attention has been given to their application.

Editor's Note

This is the first of two articles by Dr. Hollomon on "Technology in the United States;" the second, "The Options Before Us," will appear in *Technology Review* for July/August.

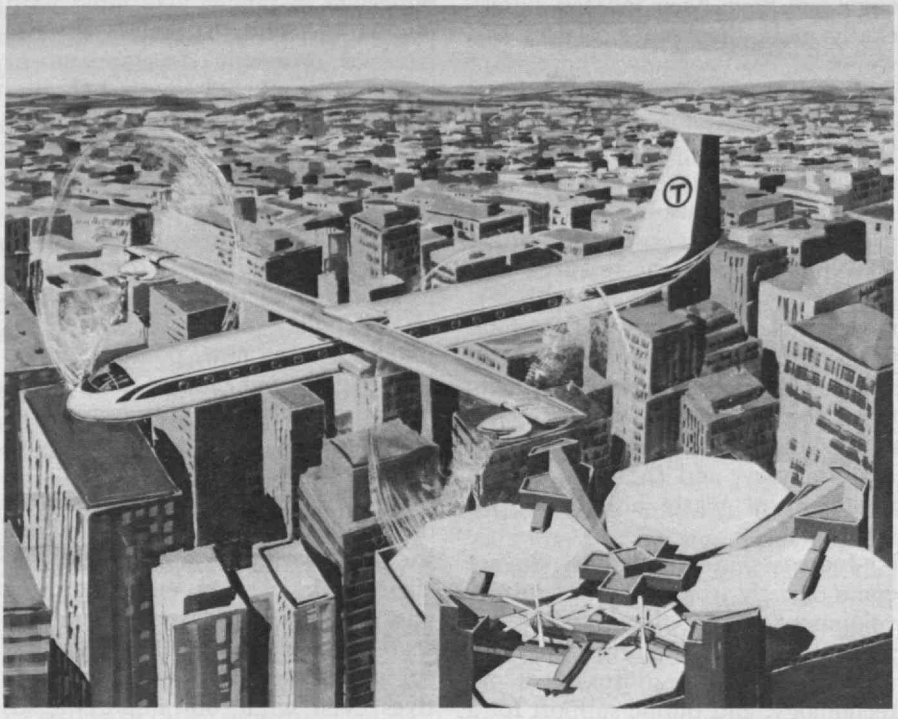
The author notes that information in these articles is based in part on a special summer study titled Alternate Federal Policies Affecting the Use of Technology, supported by the National Science Foundation. The study was carried out by Peter J. Barrer, Rebecca Donnellan, Richard B. Freeman, Sanford Grossman, Alan E. Harger, Julian Karpoff, Ralph Pochoda, Paul S. Shapiro, James M. Utterback, and Jarrod W. Wilcox. The author also acknowledges the advice and criticism of Harvey Brooks, William M. Capron, Gordon A. Christenson, Donald G. Marquis, Richard R. Nelson, Robert M. Solow, and Jerome B. Wiesner; but he specifies that these critics "are in no way responsible for what has been presented here." Specific references to individual papers and authors are not indicated in the article. This absence does not imply that what is said is not based on work found elsewhere but, rather, that the conclusions are those of the author alone. Some of the material to which reference is made can be found in a list of selected readings which will follow publication of the second article.

Rene H. Miller
Head of the Department of Aeronautics and Astronautics, M.I.T.

A Plan for Ultra-Short-Haul Air Transportation

Passenger transportation over distances of less than 100 miles represents the largest, most congested, and yet most essential travel market in the nation. This market is now dominated by the automobile—a land-hungry and polluting vehicle, but one which reduces to a minimum the need for walking and, particularly, for waiting. Our current experience is that common carriers can compete against this instant transportation with its portal-to-portal convenience only in special circumstances and even then only with the aid of massive subsidies. Indeed, our inability to solve the congestion and financial problems of short-haul ground transportation is a frustration often cited in arguments about the power of technology to serve man's needs.

Since air transportation can operate without direct subsidy over longer trip lengths, it is of interest to examine its potential for subsidy-free operations over the shorter distances traditionally served by ground transportation. This paper reports on recent work at M.I.T. to predict the share of transport demand which will go to each of the several competing modes under various conditions of elapsed time and cost; and then to assess present and future aircraft in relation to this transport demand.



Does this artist's concept of the tilt-rotor-wing aircraft operating from a city-center terminal show Boston's future intracity transportation? The author believes a strong case can be made for development of such an air-based system for trips of between 10 and 50 miles, and he urges development of demonstration projects.

Many alternatives have been proposed as a means of breaking the dominance of the individually driven automobile in the short-haul travel market. Higher-speed tracked vehicles appear attractive to many, although the capital investment required, of the order of $10 million per mile based on experience with present systems, would probably limit this mode to high-density, point-to-point transportation and hence to intercity operations rather than to the area-to-area service necessary for travel within densely populated areas. Point-to-point rail transportation will be useful to those few within walking distance of terminals in city centers, but the majority of travelers will still use cars, taxis, and buses, adding to the congested city center traffic which causes the terminal accessing problems that keep these travellers off the trains.

Helicopters have been tried as a means of providing area-to-area and area-to-point transportation, but the small, primitive, low-speed vehicles used, their excessive costs, and their unsatisfactory noise characteristics have limited their utility even for city-center-to-airport service, a market which even with the best

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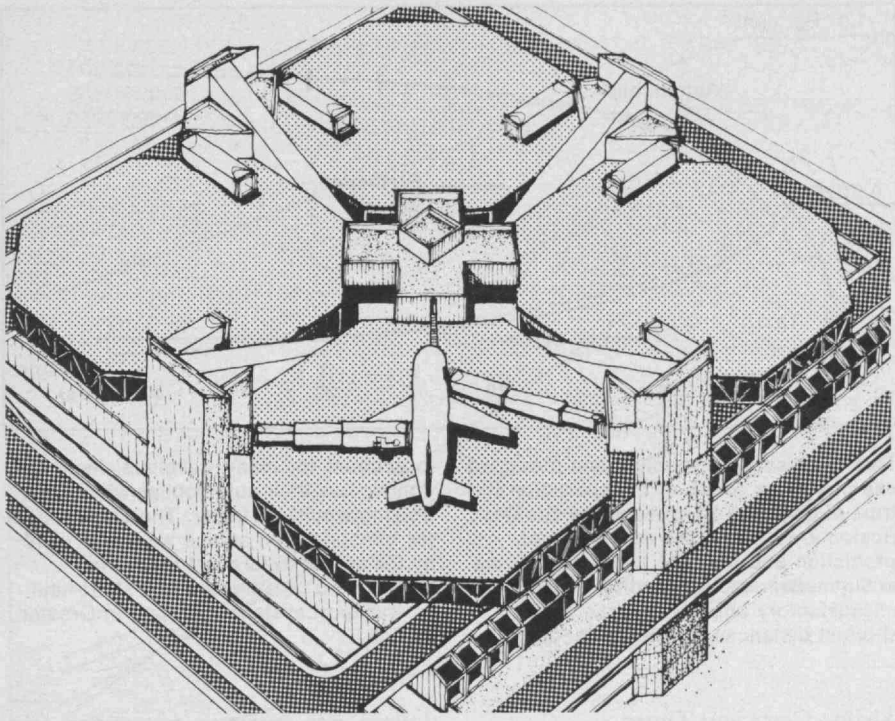
Rene H. Miller's published work has been primarily concerned with the aerodynamics and dynamics of vertical-take-off-and-landing aircraft and transportation systems. He attended Cambridge University and came to M.I.T. in 1944 after industrial experience in stress analysis at the Glenn L. Martin Co., as Chief of Aerodynamics and Development at McDonnell Aircraft Corp., and as Vice President—Engineering of Kaman Aircraft Corp. This article has been developed from the Lanchester Memorial Lecture presented by Professor Miller to the Royal Aeronautical Society in London in 1971.

The technology of vertical-landing-and-take-off aircraft has now so far advanced that a system based on such vehicles may be advocated to replace land-based transport for suburban-to-city-center trips of 10 to 50 miles.



This suggested layout for a central-city V.T.O.L. terminal shows facilities for four aircraft to unload and load simultaneously. The ground space requirements are minimal.

of vehicles could never support a common-carrier transportation system on its own at competing prices; such a system can probably be economical only if the airport is but one destination in a total zonal transportation system, with airport access a secondary rather than a primary function of the system.

But technology is changing. Continued progress in developing higher speed, quiet V.T.O.L. (vertical-take-off-and-landing) aircraft capable of operating from city centers at high frequency, in all weather conditions and with low pollution levels, now introduces a new potential for an economically viable short-haul air transportation system. Recent studies, summarized in this article, indicate that such a system could be competitive in operating costs with existing common-carrier systems and could be placed in operation without the heavy initial capital investment required for new ground transit systems.

The Nature of Urban Transportation

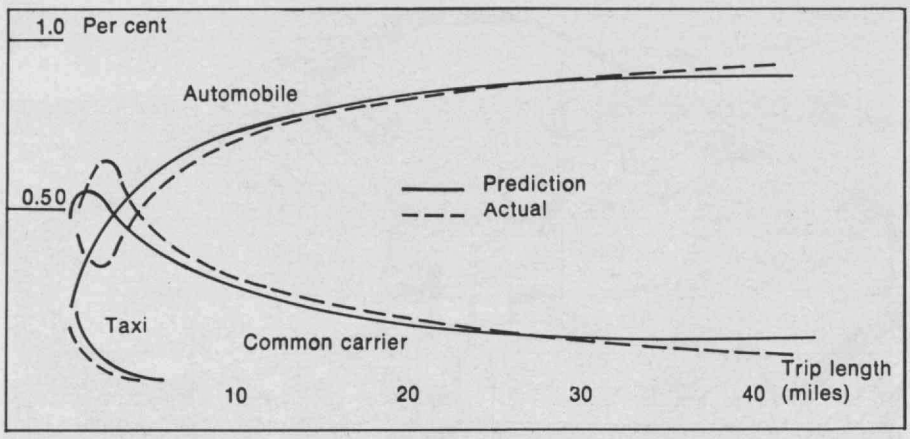
The following analysis is based on a study of the pattern of urban travel and the factors which determine the choice of travel mode in the Greater Boston area. Other urban centers differ from Boston in the transportation available and in population distribution, and therefore conclusions based on Boston as a model can be applied only in a general way to other cities. But the modelling techniques used in the following study of Boston transportation needs are believed valid for any major urban area providing the necessary demographic information is available.

The accompanying chart shows for the Greater Boston area the percentage of travel by private automobile, common-carrier transit systems (subway and bus), and taxi as a function of trip distance. In this article we are mainly concerned with travel over distances greater than five miles, and here the choice is clearly between automobile and public transportation. It is interesting, however, to note the unexpected increase—following the expected decrease—in automobile travel over very short distances, in contrast to common-carrier travel, which decreases as distances become short enough for walking. These data make clear the fundamental problem of any common carrier competing with the great convenience, availability, and door-to-door delivery of the automobile. Once the automobile has been chosen as his transportation mode and the driver is encumbered with his vehicle, he will use it even for distances which could more logically be traveled on foot.

Predicting Transportation Choices

To project potential demand for a new transportation system it is necessary to develop and calibrate a demand model based on factors which may logically influence the choice of travel mode. One such method uses the concept of elasticity, expressing the increase in demand as a function of a change in

the cost and/or quality of a product. In the case of transportation, quality includes such factors as convenience, comfort, cost, and time. Using current costs of fuel, oil, and parking for automobile transportation (assuming the average of 1.4 people per car) and present costs to the traveller for common-carrier transit, such a demand model, based on time and costs only, yields a prediction which agrees satisfactorily with actual current transportation choice except for the shorter distances; in this case the model used fails to account for the predilection for automobile travel over distances more suitable to walking. Since we are interested in travel segments greater than five miles, we may have confidence that the model gives us empirically determined values adequate for our purposes.



This chart shows the actual and predicted use of various forms of transportation for trips of less than 50 miles in the Greater Boston area. The close agreement of prediction and practice instill confidence in the model used for prediction; it is unsatisfactory only in the case of the shortest distances, where the model fails to account for many travellers' inclinations to use their automobiles when walking would be faster. The same model for transportation choice was later used by the author to forecast the traffic which could be attracted to a short-haul air transport system operating in Greater Boston.

Short-Haul Air Transportation

Having established the nature of the existing short-haul ground transportation market and the demand elasticities which seem appropriate, we can add a hypothetical air transportation mode and estimate the extent to which it could penetrate the short-haul transportation market. For this analysis we assumed vehicles capable of vertical take-off and landing (V.T.O.L.) and therefore able to land on an area not much greater than the vehicle's maximum dimensions, able to approach that area from any direction regardless of winds and surrounding obstacles. Furthermore, we assumed that these vehicles would operate with noise levels of the order of ambient urban background noise (about 70 dB.) and that they would be essentially nonpolluting. Justification for these assumptions will be discussed later in this article.

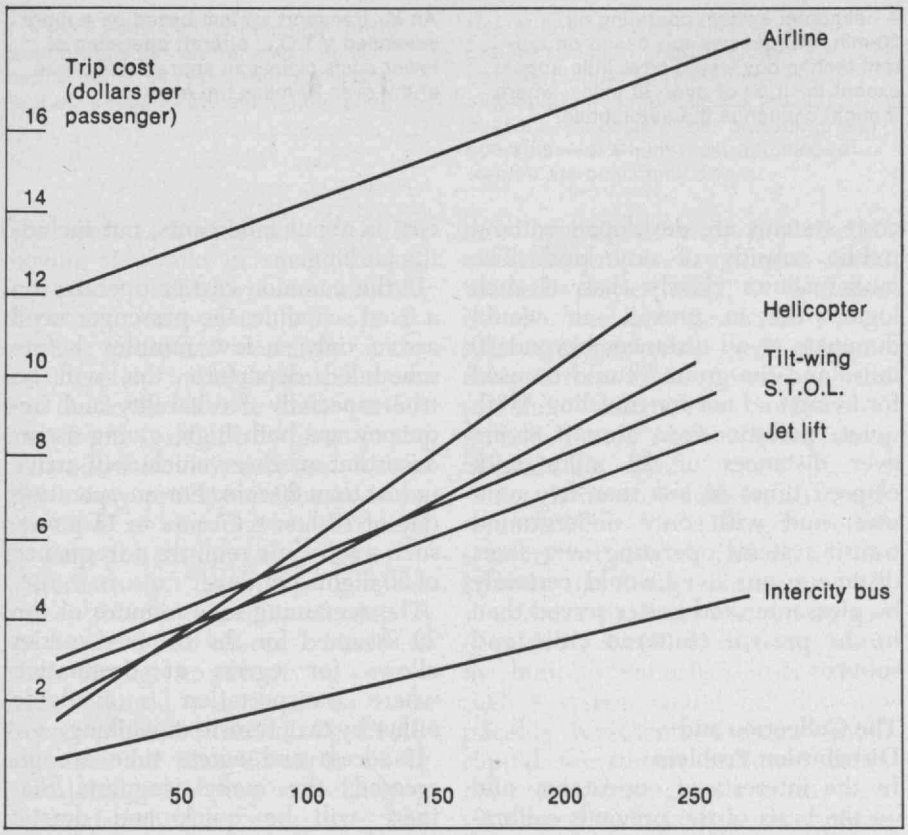
Airline Costs and Times

Several recent analyses of airline operating costs have yielded projections of possible costs for a short-haul air system of the type to be considered here. For purposes of preliminary economic analysis, there seems no need to select between the many competitive types of V.T.O.L., V/S.T.O.L., and S.T.O.L. aircraft which can be projected. Each one has advantages and disadvantages. But one basic conclusion from current studies is that total operating costs, including indirect costs, will be essentially the same for all configurations. Selecting the helicopter as typical of existing V.T.O.L. transports and the tilt-wing-rotor concept as typical of a higher speed V.T.O.L aircraft which is well within the capabilities of present-day technology and could be operational in the future, and based on a 50 per cent load factor, costs in dollars per revenue passenger trip which can be realistically expected during the present decade are:

Helicopter $\$3.34 + 0.035D$
Tilt-rotor-wing $\$1.52 + 0.025D$,

where D is the distance to be travelled in miles. These figures assume operation in a region of high demand and under a management which takes full advantage of modern techniques for optimum scheduling to achieve maximum utilization and load factor. Analysis shows that dynamic scheduling (aircraft dispatched as demand dictates and subject to constraints such as a maximum waiting time for any passenger) is attractive for a low-density market; but scheduled flying generally results in higher revenues and better service if the market justifies a frequency of 50 or more flights per operating day.

This analysis is based on terminal-to-terminal elapsed time computed



Trip cost is only one factor among many which affect a passenger's choice of transport. Given the advantages which vertical- or short-take-off-and-landing (V.T.O.L. or S.T.O.L.) aircraft can soon bring to the intracity (less than 50 miles) travel market, the author believes they will prove popular and economically viable. As far as cost is concerned, there is little to choose from among the several different configurations of short-haul aircraft.

as "block time" and "travel time." The block time, consisting of time to climb vertically, accelerate and reach cruise altitude, descend from cruise altitude, decelerate, and land vertically, are given as:

Helicopter $1.0 + 0.23D$ minutes
Tilt-rotor-wing $1.0 + 0.14D$ minutes

where D is the trip distance in miles.

No ground or air maneuvering time is included because of the anticipated method of terminal area operation discussed later.

Since a few years of operation can be anticipated before the projected systems reach their optimum schedules and fare structures, and in order to introduce a degree of conservatism into the air system analysis, the per mile costs were doubled in the economic analysis; and block times were also increased by 20 per cent to allow for a possible intermediate stop. In computing travel time 20 minutes were added to the block times to allow for access to the terminal and wait time, as was assumed previously for the ground transit system, and one minute was added for access to the aircraft at the terminal. These points will be discussed further below. Thus the estimates based upon this data are presumably conservative.

The Demand Distribution

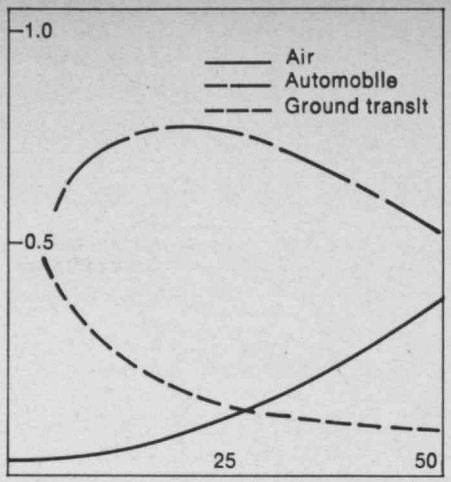
These figures for costs and travel time applied by computer to the demand model already discussed yielded the series of projections for automobile, common-carrier, and air travel shown in the charts at the top of the following pages.

In summary: a helicopter shuttle system based on current technology operating over a radius of about 50 miles from the city center with indirect costs typical of airline operations would not substantially change the present dominance of the automobile for shorter distances; but beyond 30 miles it could be expected to claim a modest share of the market. A more advanced aircraft with a tilt-rotor cruising at speeds of the order of 350 knots and operating at substantially lower indirect costs typical of a more mature system could, however, be expected to take an appreciable share of the market away from the automobile beyond 30 miles.

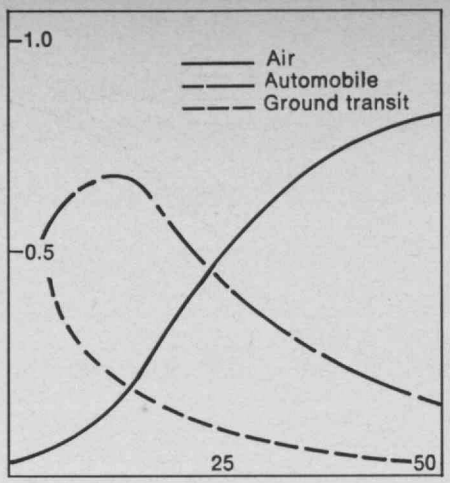
Removing the subsidy of the order of 50 per cent under which common-carrier transportation systems now operate will simply increase automobile traffic without substantially affecting the air market—primarily because the transit share is, as might be expected, over shorter distances where air can offer little help.

However, the picture changes radically if the true cost of automobile ownership and operation (including maintenance, depreciation,

The charts on this and the following pages reveal the result of studies of transportation choice when various costs, times, and availabilities are assumed for the various competing transportation modes in the Greater Boston area.



A helicopter system operating on 20-min. frequencies but based on current technology would have little appeal except for trips of over 30 miles, where it might challenge the automobile.



An air transport system based on a more advanced V.T.O.L. aircraft operating at lower costs claims an appreciable share of the over-30-miles trip market.

and taxes) is used in place of the lower apparent costs which most drivers assign to automobile use. Even with a slow, expensive air vehicle such as the helicopter and an unsubsidized public transportation system, the share of short-haul traffic performed by the automobile drops to a very small value. The market is then dominated by a logical combination of public ground transportation over shorter distance and common-carrier air over longer distances—probably an optimum system for minimum cost to society as a whole.

This logic is not likely to prevail—if only because the automobile has a greater appeal than the simple demand model fully simulates. The ability to control one's own destiny by route choice and change of destination if the whim occurs enroute, plus the privacy and comfort of the modern automobile, will probably always drive the demand distribution toward this personal form of transportation.

Much interest now centers around concepts of high-speed ground transportation. The model suggests that such a system, subsidized so that costs are comparable to present-day transit costs and with block speeds of 40 m.p.h. between terminals, could be competitive with air transportation over the shorter distances and could be expected to share the market even at distances greater than 30 miles. And it would serve the very useful purpose of reducing the automobile's share of the market.

It is of interest to consider an ideal world in which each trip is charged according to its true rather than apparent costs, regardless of mode. In such a model, competing high-speed transit systems and advanced aircraft systems are developed without public subsidy of any kind. The model shows clearly that, if such logic were to prevail, air would dominate at all distances beyond 10 miles and the ground could be used for living and not for traveling. With quiet, pollution-free aircraft flying over distances of 20 miles with elapsed times of less than five minutes, and with only underground transit systems operating over short distances, our lives would certainly be pleasanter and better served than in the present cluttered cities and suburbs.

The Collection and Distribution Problem

In the interests of consistency and on the basis of the previous calibration with existing systems, the model assumed a 20-min. access-and-wait time for all common-carrier transportation systems, both air and ground. There is, however, a real question as to whether such access times are achievable if a high-speed air or ground system is introduced in a total suburban complex. We therefore propose a somewhat modified transportation model, with stations and/or air terminals serving areas of ten miles' radius around population centers.

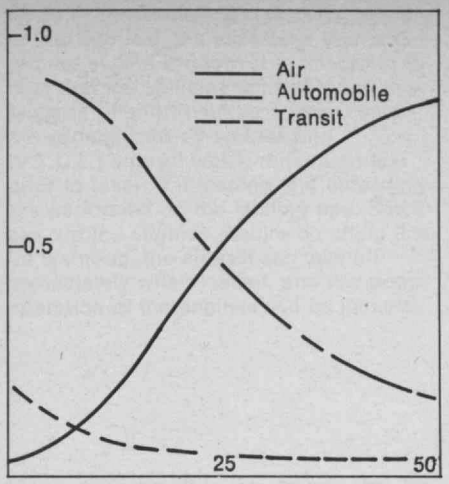
Access to these terminals is assumed to be by private automobile; and if average car speeds in the suburban areas are to be assumed to be of the order of 40 m.p.h. the average time required to access the terminal is six minutes and the corresponding cost is about nine cents, not including parking.

If the common carrier operates on a fixed schedule, the passenger need arrive only a few minutes before scheduled departure; this will be true especially if reliability and frequency are both high, giving assurance that another vehicle will arrive in less than 20 min. For an operating day of 16 hours (7 a.m. to 11 p.m.), such a schedule requires a frequency of 50 flights per day.

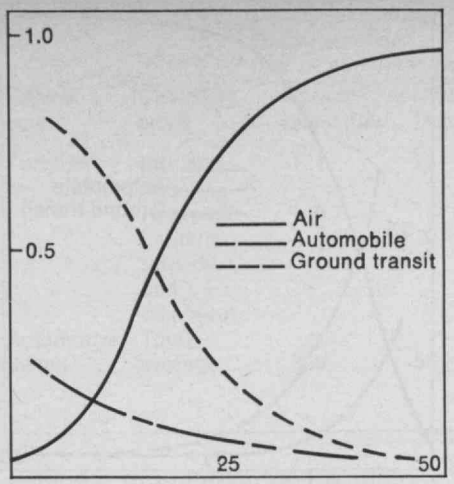
The remaining nine minutes of the 20 assumed for the common-carrier allows for egress at destination where transportation is available either by taxi, transit, or walking.

If access and egress time are increased, the model suggests that there will be quick and drastic changes in transportation choice, and this analysis, applicable to both high-speed ground and air, suggest the importance of considering micro-collection and distribution before investing in an extensive advanced transportation system. Better methods of providing individual transportation are urgently required if we are to make effective use of present-day technology for improved transportation in urban and suburban areas.

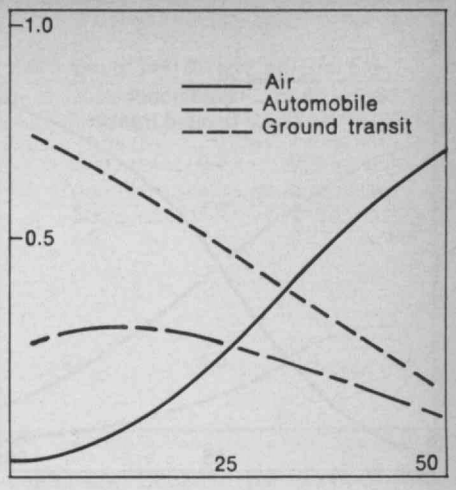
Generally this means the provision of some ground transportation mode for distances of less than five miles, which could never be successfully served by air. A major effort must therefore be made to develop high-speed, comfortable, clean, non-polluting subway systems to serve the



If present subsidies for common-carrier ground transport are removed, automobile traffic increases but the short-haul air transport system is little affected.



Use of unsubsidized common-carrier ground transport and the slower air transport would increase markedly if automobile transportation is asked to bear the full costs of car ownership and operation—of which most automobile owners are only dimly aware.



Subsidized, new high-speed ground transportation could claim a substantial share of the under-30-mile trip market—and a lesser share of the 30-to-50-mile trips.

city centers. People-movers, either moving sidewalks or small, tracked four-place vehicles automatically dispatched and controlled, are attractive prospects currently under consideration for high-density areas. For the lower density areas further consideration should be given to the demand-sensitive microbus system which may provide economic transportation at considerably less cost than the present-day taxi system.

Alternatively, "disposable" cars are conceivable in which ownership is not involved and charge is based on usage through an identifying key, or card, required to activate the unit. Power could be electric, perfectly adequate for the distances being considered, with plug-in recharging at stands while awaiting use. The capital invested in these small vehicles would be such that a high rate of usage might not be necessary in order to provide reasonable transportation when compared to the high true cost of the private automobile.

In comparing these costs with present-day public transportation systems, it should be noted that the heavy subsidies required to keep these public systems operating mask their true costs and make comparison between competing systems difficult.

High-Speed Ground vs. Air

For trip lengths below 50 miles, ground transit systems without the burden of capital amortization currently operate at lower costs than those postulated for air. If such costs could be projected to higher-speed tracked vehicles, then, as indicated by the analyses discussed above, such systems could well become competitive with air systems and the private automobile. However, ground transit must operate on a cleared right of way.

Though no cost analyses in depth are available for advanced ground systems because of the many unknowns involved, experience has shown that the cost of acquiring and developing a right of way in a heavily built-up suburban area where such a system would be most applicable represents a major initial capital investment and will cause the true operating costs of any new system to be much higher than those of existing public transit systems.

In contrast, no rights of way are required for air, major capital investment being in the vehicles. It is thus possible to "grow" an air transportation system of small size with a small initial capital investment, adding vehicles as demand develops. The risk involved is much smaller.

For example, we postulate below a system which requires initially only 20 aircraft to serve an entire area, requiring a capital investment of less than $1 million per mile. The fact that suburban airports for V.T.O.L. service need not be elaborate provides two additional advantages: the cost can be kept low, and the location can be changed as market demand changes seasonally or more slowly. No such flexibility exists in ground transit systems, since once the rails are laid down the system is destined to serve the same points for the rest of its existence.

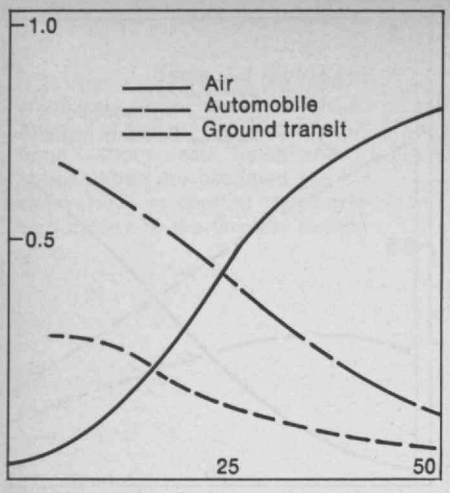
Two other issues should be mentioned. Rail has the advantage of making frequent stops along the line to pick up passengers; but not many such stops can be made if the system is to maintain a 40-m.p.h. block speed. Experience with helicopter airlines indicates that enroute stops —including approach, unloading, loading, and departure—can be made in less than two minutes, with less than one minute of ground time.

Dispatch reliability under poor weather conditions appears in the light of present technology to favor ground transportation; but this temporary advantage will be eliminated by the advanced concepts in aircraft guidance and control discussed below.

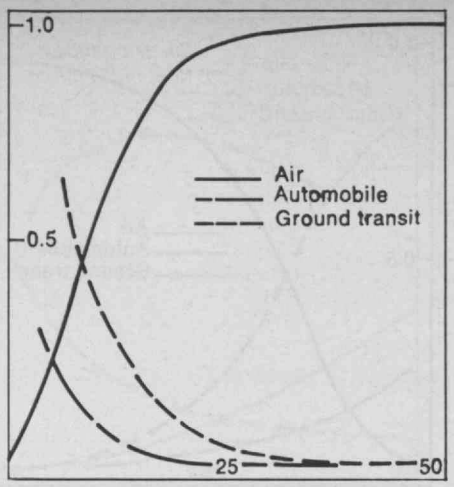
A Hypothetical Air Transportation System

In order to estimate the feasibility of an urban and suburban air common carrier, a hypothetical system has been modeled for the Greater Boston area, with results shown in the chart above. Airport locations were chosen somewhat arbitrarily but essentially centered in areas of approximately ten miles radius. We assumed that existing public ground transportation is retained with subsidy, and we used apparent automobile costs rather than the higher actual costs.

To this transportation matrix we



Without subsidy, their full costs passed on to their riders, high-speed ground transportation systems lose riders to automobiles and aircraft.



An unsubsidized advanced air transportation system competes successfully with unsubsidized common-carrier ground transportation and automobile transport priced at its true, full cost.

added an advanced, mature air transport system using 80-passenger V.T.O.L. vehicles and operating without subsidy. We used two alternative sets of cost and access time assumptions and 50 per cent load factors. The results showed that—especially with the lower cost and favorable access assumptions—most of the Boston-bound trips from suburban and regional terminals generated more-than-adequate demand for the postulated frequency of 50 flights a day. Some, such as Providence-Boston, justified either a much higher frequency or multiple destinations in the city centers.

In addition to the perimeter-to-center service shown in the chart, the Boston area will require circumferential, belt-type operations in the suburban regions—clearly a multiple-stop service—unless such travellers are required to go into Boston and out again to complete their journeys. Service meeting this need may be expected to increase station costs and travel times for some passengers, and thus somewhat to reduce demand.

Aircraft costs were based on a utilization of 2,300 hours per year. This allows 50 flights per day over typical trip lengths with 100 per cent standby equipment. Maintenance is undertaken at night, when vehicles are out of service. Approximately 20 vehicles would be required for the higher-cost, slower Case I assumptions and 60 for Case II.

The table on page 25 indicates that the penalty of increased access cost and access time is particularly critical at the shorter distances. But where the traffic is low, service could still be provided by multi-stop routing, possibly using smaller vehicles. Optimization of a network of this type with multi-commodity flows is an interesting exercise in transportation analysis for which the tools are only now being developed. Our data suggest that optimized scheduling for such a system will certainly develop a viable transportation network which may be expected to grow in a logical fashion given a high quality of service and dispatch reliability.

Clearly such an air transportation system could serve a useful function in relieving ground transportation and providing rapid communication between centers of population even in an area of relatively low population density such as Boston and vicinity. Imponderables remain. Neither the market size nor the most optimistic demand predictions suggest that more V.T.O.L. airports than those listed in the table could be expected in the near future. If access to these is constrained—and particularly if use of a private automobile is required—V.T.O.L. utilization will decrease as travellers tend to drive to their destinations without stopping at the V.T.O.L. port.

These and the many other imponderables involved in predicting the preferences and prejudices of the traveling public as well as the operating problems of a short-haul, high-speed air transportation system make experimental programs and demonstration projects necessary. Only if these are initiated quickly, while transportation options remain open, can we answer some of these vexing questions.

Advances in Aircraft Engineering

The technology for V.T.O.L. aircraft suitable for such a transportation system is progressing rapidly, and one may forecast with confidence the solution of such hitherto vexing problems as noise, air pollution, and aircraft flight characteristics. Much of this progress was reviewed in detail by Henry Faulkner in an earlier article in this series, and I cite below only those factors which especially impinge on a metropolitan short-haul transit system.

Noise

To be acceptable in the community they serve, aircraft being considered for a short-haul urban and suburban transportation system must operate at noise levels not much higher than ambient urban levels, or below 80 dB. We are still at an early stage of noise control in V.T.O.L. rotor aircraft, and much additional work —both experimental and theoretical —is needed before we can state with assurance that these aircraft will present no noise problem in urban operations. However, recent success with quieting helicopters has resulted in spectacular noise reductions, and there is every reason to believe that, with sufficient design effort, noise levels of 70 dB. at 300 ft. may be possible in approach and landing, with 60 dB. at 1,500 ft. not an unreasonable goal in cruise flight. The same reductions appear possible in tilt-rotor aircraft through blade modifications. Further reduc-

At other than low-power settings typical of idle and taxi, the emissions from a gas turbine engine are low. It is important to note that the vehicles considered in this analysis of short-haul air transportation are vertical-take-off-and-landing (V.T.O.L.) aircraft which require no taxi prior to take-off if loading and unloading are performed on the landing pad. Since gas turbine engines require no idling time for warm-up, the aircraft can take off immediately when loaded, and low-power operation of the engines will be minimal.

		Emission index (lbs. of pollutants per 1,000 lbs. of fuel consumed)					
Engine type	*Operating mode*	*Carbon monoxide*	*Hydro-carbons*	*Nitrogen oxides*	*Partic-ulates*	*Lead*	*Sulfur oxides*
Turbojet	Idle and taxi	174	75	2.0	0.3	0	1.0
	Approach	8.7	16	2.7	1.0	0	1.0
	Landing, take-off, and climb-out	0.7	0.1	4.2	0.6	0	1.0
Automotive piston	Total average	300	55	27	4.5	0.4	2.3

tions are possible in cruise by reducing rotor speed.

A penalty of approximately 20 per cent in direct operating cost is apparently associated with this proposed noise reduction for the tilt-rotor. But in context of the total costs, including indirect, this represents a cost increase of only 10 per cent. We conclude that aircraft designed for city-center operation with consideration given to noise constraints will not be appreciably more expensive to operate than current aircraft designed for minimum direct operating cost. Indeed, we may fairly predict that these aircraft can be good neighbors as far as their noise signatures are concerned—being almost inaudible in cruise flight and operating well below ambient city noise levels during landing and take-off.

Pollution

Air pollution resulting from the exhaust emissions of aircraft engines will also be a serious question in considering the operation of greatly increased numbers of aircraft in urban and suburban areas. But advanced V.T.O.L. aircraft will utilize gas turbine engines, operating at air-to-fuel ratios of the order of 60, approximately four times those of reciprocating engines. Combustion is far more complete, and there is a much lower emission of carbon monoxide and particulates. Emission of oxides of nitrogen is also appreciably lower in gas turbines than in reciprocating engines. V.T.O.L. aircraft can take off immediately after loading; idle and taxi time are minimized, and at no point in its flight cycle will such an aircraft contribute any appreciable amount of pollution due to engine operation.

It is of interest to compare the contribution to pollution of the aircraft being considered here with the pollution caused by burning hydrocarbon fuels. A typical automobile in urban areas uses 0.285 lbs. of fuel per passenger-mile, while advanced helicopters and tilt-rotor-wing vehicles consume 520 lbs. of fuel for a trip of 30 miles. Since these are 80-passenger vehicles and the average load factor has been taken as 50 per cent, this gives a fuel consumption of 0.45 lbs. per passenger-mile. The table makes it evident that the emission per passenger-mile of the automobile as it exists today will be 280 times higher than the aircraft's for carbon monoxide, 350 times higher for hydrocarbons, and four times higher for oxides of nitrogen. Clearly the substitution for automobile transportation of the common-carrier air transportation system considered here would be highly desirable as a means of reducing atmospheric pollution in urban and suburban areas.

Dispatch Reliability and Safety

For an effective suburban air transportation system, aircraft must maintain a high degree of dispatch reliability even under instrument flight conditions approaching zero visibility; and they must maintain and even exceed the enviable safety record of air transportation during recent years.

All aircraft considered in this study are designed to be capable of maintaining altitude and returning to a landing area in the event of an engine failure at any point in the landing and take-off cycle. In theory, all V.T.O.L. aircraft should be reliable and safe in the landing mode, even during instrument flight conditions, because they achieve independent control of vertical and horizontal velocities. Because the aircraft can fly very slowly or hover stationary in the air when in doubt or in order to avoid other vehicles on the ground or in flight, air traffic control procedures should be far simpler than for conventional aircraft.

Unfortunately, these inherent potentials of V.T.O.L. aircraft for safe all-weather operations have in practice been masked by their poor handling qualities. However, inertial stabilization systems now under development for V.T.O.L aircraft will permit any desired control characteristics in the vehicle, providing only that sufficient control power is available.

A V.T.O.L. aircraft equipped with such control systems is very simple to fly and land, even under instrument flight conditions without visual contact with the ground. Such an aircraft will be able to approach its landing pad from any direction regardless of the wind conditions. This is important not only to permit approach from any direction but also to allow backing up as necessary to maintain position in hover. With this capability the aircraft may approach the landing pad directly, and air maneuvering will be minimized; the multiple approach path possible with V.T.O.L. aircraft will thus increase the acceptance rate of the terminal by an order of magnitude.

The market postulated in the table on p. 31 could be served by some ten vehicles in the air at any time, assuming a 20-minute schedule from eight suburban stations serving the core city terminal. There would thus be a landing at the city terminal every two minutes if only one terminal were provided in Boston proper and all flights were non-stop. With several landing pads at the terminal and using the omni-direc-

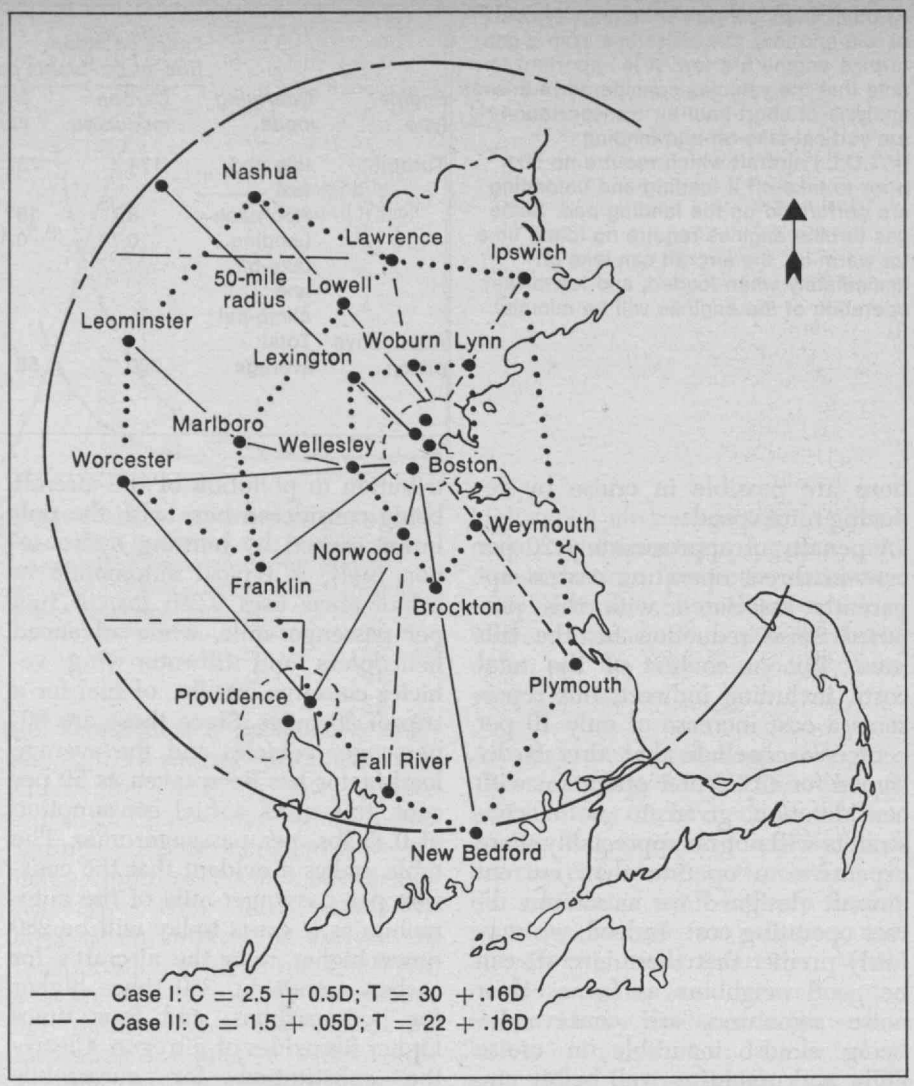
tional flight and tight position control capability of V.T.O.L. aircraft, the terminal area traffic could be handled without any congestion problems.

Because of the short flight times, it is quite possible that air traffic control could be based on scheduling all aircraft positions at all times, with the situation monitored from a central facility. Thus an aircraft leaving a suburban terminal would travel to its destination with its path clear enroute and with its own space reserved in the terminal area.

Summary: An Airborne Alternative

Ultra-short-haul travel, characterized by trip lengths of less than 50 miles, represents the single largest block of travel in the nation. It is dominated by the automobile, which is characterized by portal-to-portal convenience, low apparent cost, high true cost, and high hidden costs in terms of community disruption, air pollution, and traffic congestion. Common-carrier systems such as bus and rail have not succeeded in capturing enough of this market to alleviate the problems associated with automobile travel; indeed, such systems carry an ever-decreasing share of short-haul transportation.

New technological developments now suggest a different alternative: a satisfactory common-carrier air transportation system may be economically viable over short distances, and it will surely be environmentally acceptable. Such a system could provide a solution to the problem of center-city access from outlying suburban areas; and it could as well change our entire concepts of urban complexes. The ability to travel 30 miles comfortably in six minutes at ten cents a passenger mile would put an entirely new dimension on our concepts of city centers and their environments. It would represent a new social tool permitting suburban living for all who might desire it, regardless of income, and yet still allow urban living for those who may prefer.



For purposes of study, the air transport network shown above, using advanced V.T.O.L. 80-passenger aircraft, has been hypothesized to offer service at 20-minute intervals between Boston and all outlying stations. The air transport demand under two different cases is then shown in the chart at the right. Case I assumes the higher costs and total trip times shown, resulting from problems of access to air terminals; Case II assumes the ideal access conditions and would justify the additional service indicated by dashed lines on the map. Under Case II conditions, circumferential service with 20-passenger aircraft could be justified on routes indicated by the dotted lines. The) indicates a trip with one intermediate stop.

	Population ($\times 10^3$)	Population ($\times 10^3$)	Distance (miles)	Estimated 1960 daily one-way demand	Case I		Case II	
					Per cent of market	Load/trip	Per cent of market	Load/trip
Worcester-Boston	323	1,362	40	6,750	42	66	76	123
Lowell-Boston	161	1,362	23	5,749	14	20	46	64
Nashua-Boston	86	1,362	34	1,936	30	14	68	32
Providence-Boston	816	1,362	42	15,700	44	167	78	294
Leominster-Boston	82	1,362	40	1,680	42	17	76	31
Marlboro-Boston	121	1,362	27	3,600	20	18	55	50
Ipswich-Boston	107	1,362	26	3,349	18	15	52	42
Newburyport-Boston	143	1,362	50	2,300	58	33	83	46
Brockton-Boston	146	1,362	20	5,982	9	13	37	53
Franklin-Boston	109	1,362	26	3,350	43	36	77	64
Lawrence-Boston	162	1,362	26	5,147	18	22	52	65
Norwood-Boston	151	1,362	11	11,100	2	5	10	27
Fall River-Boston	100	1,362	46	1,796	58	25	80	35
Lynn-Boston	243	1,362	11	17,500	2	8	12	51
Woburn-Boston	117	1,362	10	9,500	2	5	11	25
Lexington-Boston	140	1,362	13	9,000	4	9	17	37
Wellesley-Boston	108	1,362	10	8,744	2	4	11	23
Weymouth-Boston	195	1,362	10	15,920	2	8	11	42
Plymouth-Boston	72	1,362	33	1,776	30	13	67	29
Lynn-Brockton	243	146	30	700	24	4	61	10
Leominster-Worcester	82	323	20	800	11	2	37	7
Lexington-Marlboro	140	121	19	530	8	1	36	5
Providence-Worcester	816	323	38	4,113	40	40	75	75
Worcester-Franklin	323	109	26	816	18	4	52	10
Providence-Franklin	816	109	18	2,895	9	6	34	24
Newburyport-Providence	143	816	30	2,320	24	13	61	34
Marlboro-Worcester	121	323	13	1,700	4	2	18	7
Lynn-Lexington	243	140	15	1,350	4	1	21	7

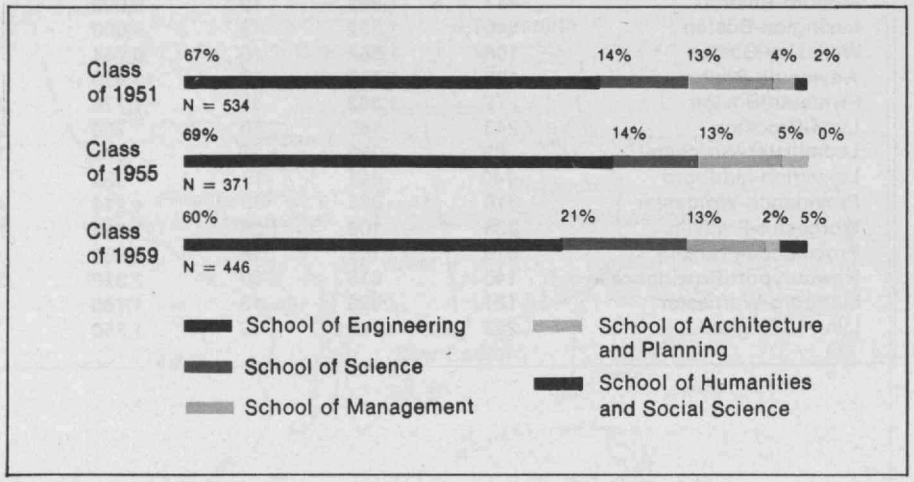
by Lotte Bailyn and
Edgar H. Schein
with Marc S. Gerstein
and H. Dany Siler
Sloan School of Management,
M.I.T.

Where Are They Now, and How Are They Doing?

What happens to people with a technological education? What kind of work do they do 10, 15, and 20 years after graduation? In what kind of organizations do they work? How much money are they making? Do they think they are successful? To what do they attribute their success?

The answers to such questions are elusive, because both people and their educations differ so widely. Those answers that follow are based on data from a major survey of alumni of the Massachusetts Institute of Technology in the Classes of 1951, 1955, and 1959, conducted in 1970 by a research team at the M.I.T. Sloan School of Management. The project was supported by the Office of M.I.T.'s Undergraduate Planning Professor and by the Carnegie Commission on Higher Education as part of a more general study of the form and timing of higher education in the professions.

The purpose of the project was to obtain basic information about the careers of alumni, their attitudes toward their undergraduate and graduate education, their feelings about work and family, and their suggestions as to how institutions such as M.I.T. could productively continue some relationship with their graduates.



Studying the response to their education by technological institute graduates, the authors surveyed by questionnaire the M.I.T. Classes of 1951, 1955, and 1959. The chart above shows the fields in which the questionnaire respondents—some 61 per cent of those surveyed—graduated from M.I.T. (Comparison with the figures for all the graduates in these three classes shows that as far as undergraduate majors are concerned, the sampling distribution is virtually identical to that of the population.)

The Classes of 1951, 1955, and 1959 were chosen because their members had been out of school long enough to become well established in their careers. We did not choose earlier classes because of the intervention of World War II, and we did not choose more recent classes because too many of their members would still be in graduate schools or in the very early phases of career establishment. We surveyed all members of a few classes rather than selected samples from many classes in order to control as much as possible for the educational environment which may have existed at any given time. Questionnaires were sent to 2,227 alumni, and usable responses were obtained from 61 per cent of those surveyed, a most gratifying response. (There were 22 women graduates in these three classes, of whom 15 responded to the questionnaire. Their responses have been analyzed elsewhere and are not included in the present report.)

The Sample

In the decade of the 1950s, almost two-thirds of M.I.T.'s students received their degrees from the School of Engineering; only about 15 per cent took degrees in fields in the School of Science, and nearly the same number completed work in the Sloan School of Management; less than 5 per cent majored in architecture or in humanities and social

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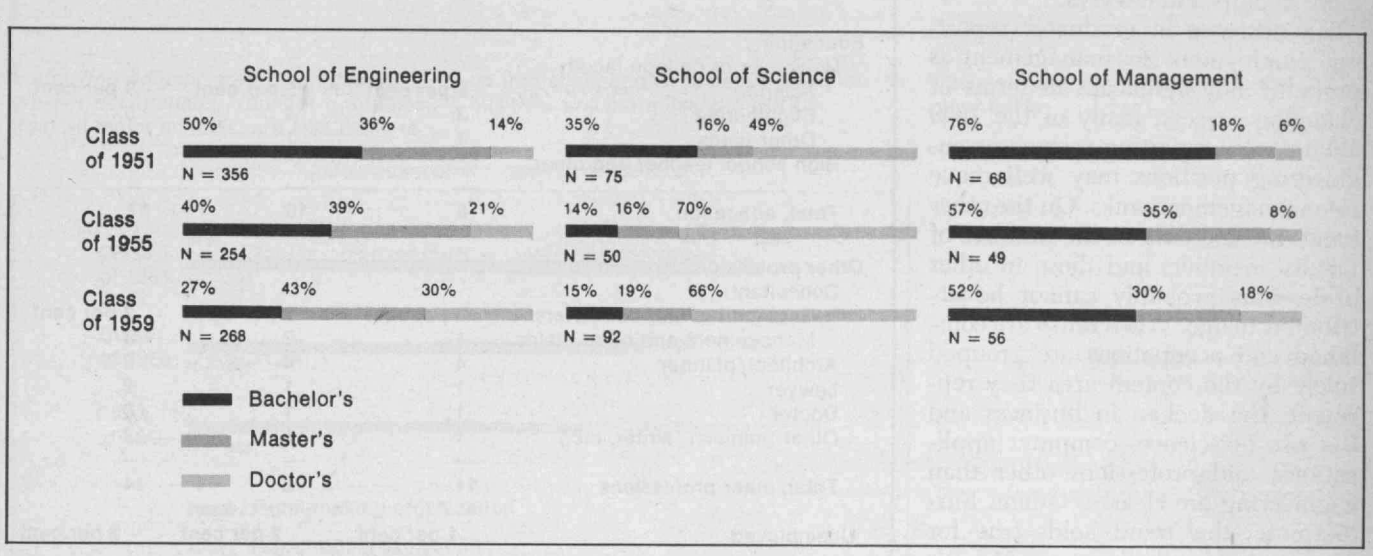
The in-depth study of M.I.T. alumni reported here, co-sponsored by the Institute and the Carnegie Commission on the Future of Higher Education, was initiated by **Edgar H. Schein** in his role as Undergraduate Planning Professor at M.I.T.; he has now returned to full-time teaching and research as Professor of Organizational Psychology and Management in the Sloan School of Management, with which he has been associated as a member of the faculty since 1956. **Lotte Bailyn,** who came to M.I.T. in 1969 following research and teaching at Harvard, is Associate Professor of Organizational Psychology and Management. **Marc Gerstein** is a doctoral candidate and **Dany Siler** a Research Assistant associated with Professors Schein and Bailyn in analyzing the alumni survey results.

Surveying over 2,000 M.I.T. graduates of the 1950s, the authors find the best paid are in management positions and the least successful by their own perception are in engineering jobs.



Did you attend graduate school? Increasing numbers of younger M.I.T. alumni answer "yes," and increasing numbers of them have studied for the highest graduate degrees.

science. But as the decade ended the preeminence of the School of Engineering was beginning to decline, with increasing numbers of graduates coming from the School of Science and, secondarily, the School of Humanities and Social Science. This trend has become much more marked in the decade that followed: 36 per cent of the graduates from the Class of 1971 received degrees in engineering; 38 per cent in science; 6 per cent in management, 8 per cent in architecture, and 12 per cent in humanities and social science.

Another trend already evident during the 1950s and undoubtedly accentuated since is the tendency to consider the M.I.T. undergraduate degree as only one step in a formal education rather than its completion. A larger proportion of members of the more recent classes in the survey have proceeded to graduate schools, and more of those students who have done so have continued studies to attain a doctorate or its equivalent. We also find, not surprisingly, that science graduates are most likely to go on to graduate school, management graduates most likely to stop with their S.B. degrees. But in each field, the trend by time is evident: the S.B. is less and less likely to be seen as a terminal degree.

Where Are They Now?

Twenty years after graduation, over 50 per cent of the respondents from the Class of 1951 are in some form of management; another 25 per cent perform technical functions as employees of organizations; 5 per cent are employed as business staff in organizations; 6 per cent are in education; and the remainder are in other professions. (The reader must be cautioned that, even though our sample represents more than 60 per cent of the total population surveyed, the percentages may not be a completely reliable indicator of the actual proportion of alumni in the different occupations. Short of an expensive telephone survey, we have no way of knowing whether nonresponse is correlated systematically with occupation.)

The class of 1955 shows a very similar profile; a slightly smaller proportion of its members is in management, and slightly larger proportions are in education and the other professions. This trend be-

comes clearly visible in the Class of 1959, where there are many fewer managers and more technical employees, educators, and other professionals.

Other small trends are also apparent: computer specialists were essentially a new category of employment for the Class of 1959; university faculty are increasing, particularly in science and "other fields" (which consist mainly of the social sciences and management); a new business role, that of the management consultant, is emerging; and there are fewer architects but more doctors and lawyers.

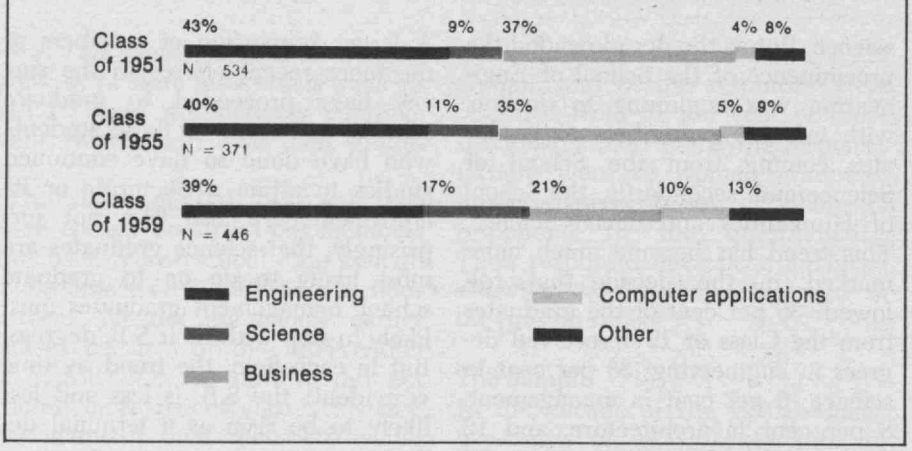
The decrease in graduates reporting employment in management is probably not significant in terms of changing careers; many of the 1959 alumni now reporting science or engineering positions may well move into management ranks. On the other hand, the increase in the number of faculty members and those in other professions probably cannot be attributed to age. When ranks are combined and occupations are grouped solely by the content area they represent, the decline in business and the rise in science, computer applications, and professions other than engineering are clearly evident. Furthermore, this trend holds true for graduates of all three of M.I.T.'s major schools—engineering, science, and management. Even management graduates from the youngest class show an increased tendency to be in occupations not solely centered on business. It should also be noted that most graduates tend to work in the field from which they graduated, though there is a strong tendency for engineers to see business as their principal field, rather than engineering, as they move into management positions.

Our data reveal a clear trend among M.I.T. graduates away from employment in the private, profit-making sector toward non-profit institutions—laboratories and universities—and local or federal government; 81 per cent of the respondents from the Class of 1951 are employed in the private sector and only 12 per cent are in non-profit institutions; the equivalent figures for the class of 1959 are 65 per cent private and 27 per cent non-profit.

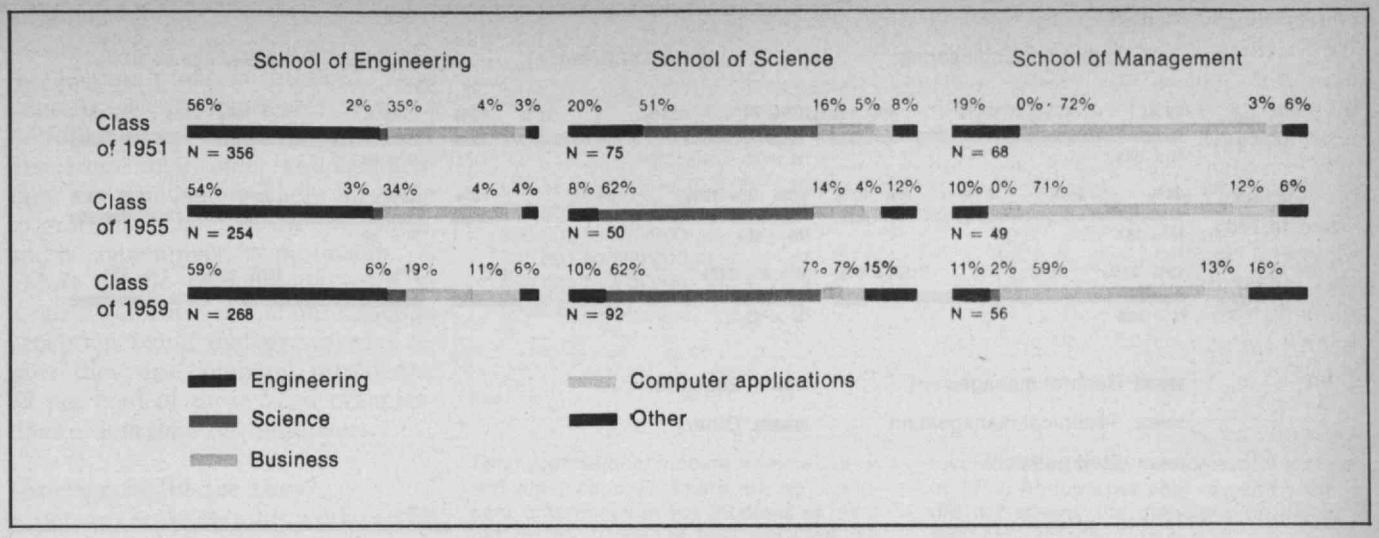
This trend is true even for graduates from the Sloan School of Management. But it is particularly evident among science graduates, the

	Class of 1951 N=534	*Class of 1955 N=371*	*Class of 1959 N=446*
Management:			
Company president	9 per cent	6 per cent	3 per cent
General manager	21	21	10
Technical manager	21	20	16
Other management	1	1	*
Total, management	**52**	**48**	**29**
Company or laboratory (non-management):			
Scientist	4 per cent	4 per cent	6 per cent
Engineer	20	16	23
Computer applications	1	2	5
Total, technology	**25**	**23**	**34**
Business staff	**5**	**5**	**5**
Education:			
University or college faculty:			
Science	2 per cent	5 per cent	9 per cent
Engineering	3	4	5
Other fields	1	1	3
High school teacher and other	*	*	*
Total, education	**6**	**10**	**17**
Other professions:			
Consultant:			
Engineering and computers	3 per cent	2 per cent	2 per cent
Management and other fields	1	2	3
Architect/planner	4	4	2
Lawyer	1	1	2
Doctor	1	1	3
Other (minister, writer, etc.)	1	2	2
Total, other professions	**11**	**12**	**14**
Unemployed	**1** per cent	**2** per cent	**2** per cent

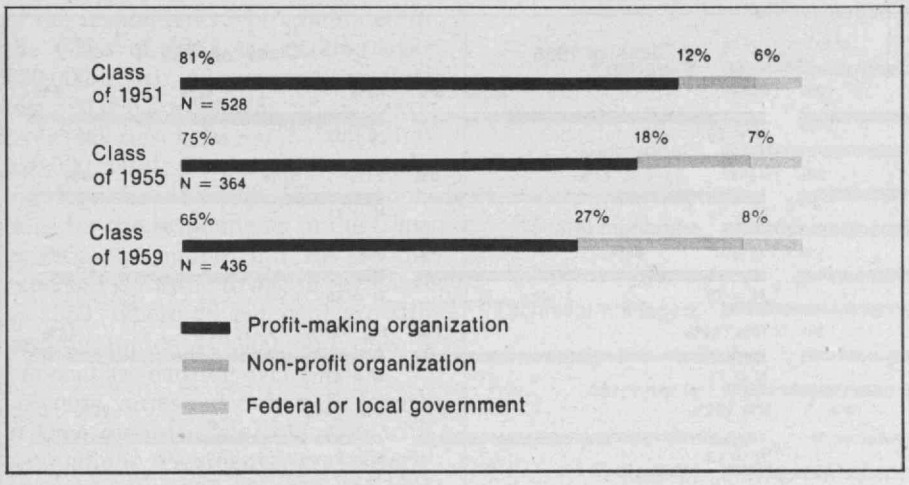
Present occupations of alumni. Older M.I.T. graduates are likely to be in some form of management; larger proportions of younger graduates are in teaching and other professions. The asterisk indicates 0.5 per cent or less.



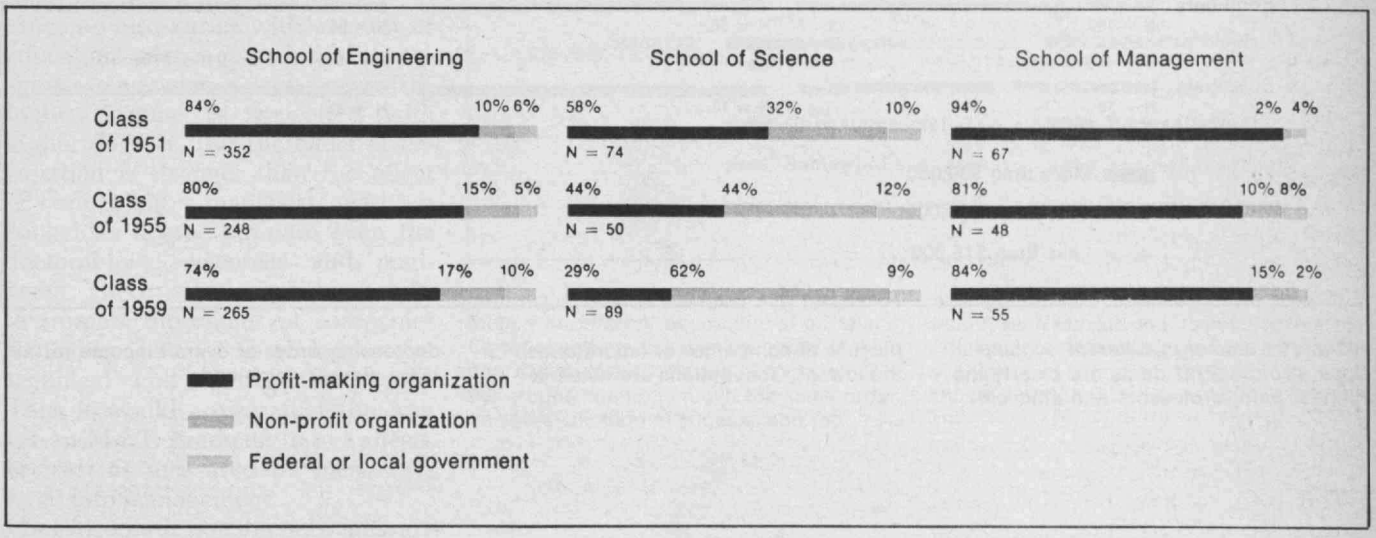
The underlying content area of the present occupations of alumni. In this analysis, occupations are categorized in terms of whether their primary orientation is technical or business, and whether emphasis is on science, engineering, or computer applications. This categorization combines ranks and focuses more on the underlying basis of the occupation.



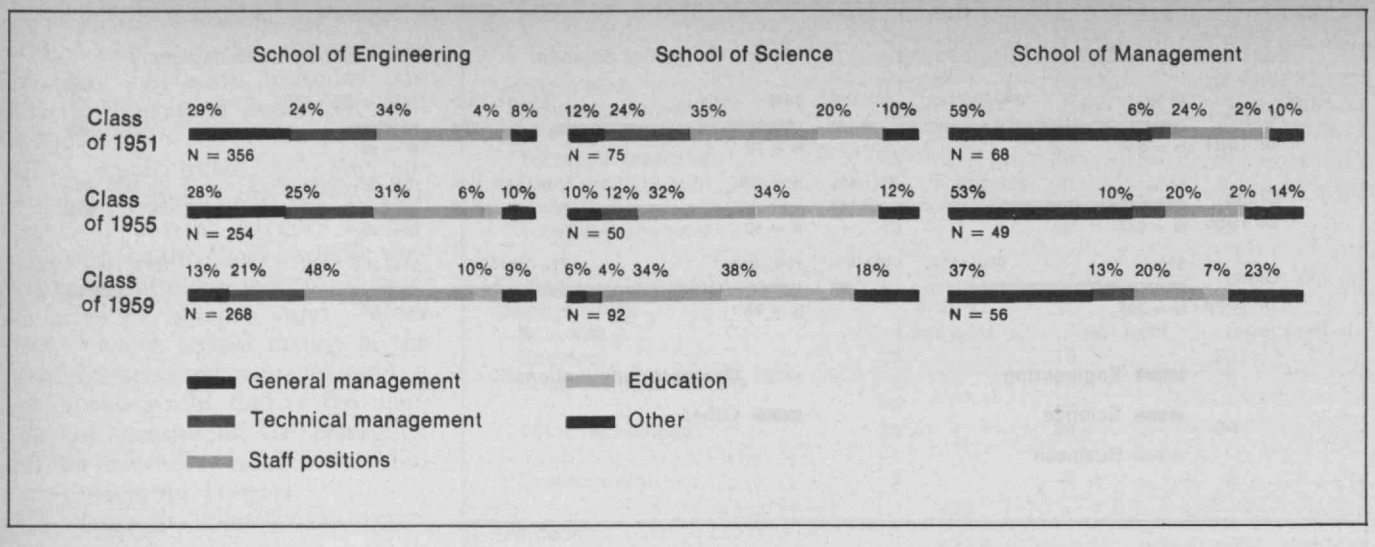
Underlying content area of graduates' present occupations. Younger graduates, from all major schools, are less likely to go into occupations centered solely on business and more likely to work in science, computer applications, and other fields.



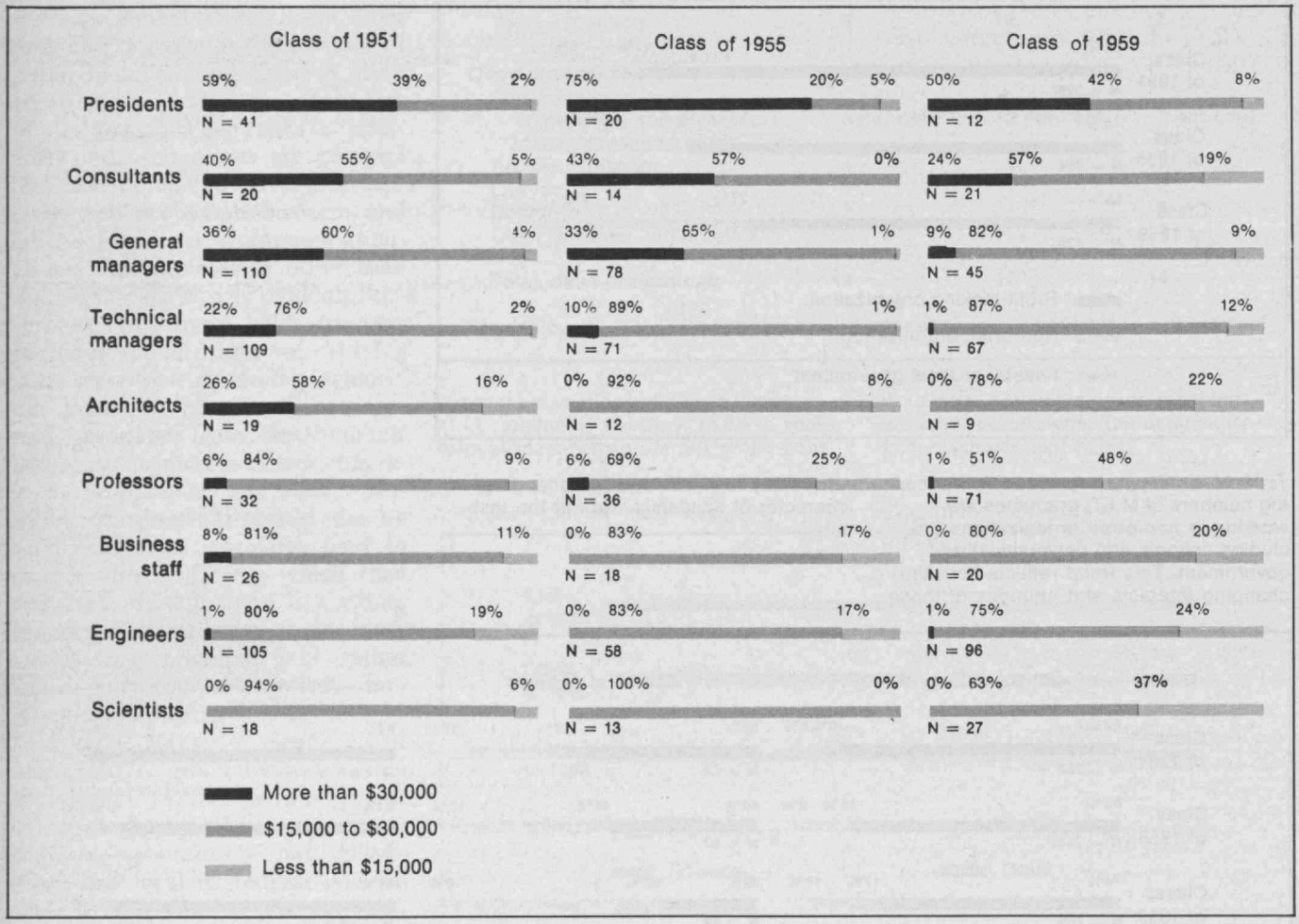
Type of employing organization. Increasing numbers of M.I.T. graduates are working in non-profit organizations (including schools and universities) and government. This trend reflects both the changing interests and attitudes of those who study at M.I.T. and the changing character of academic work at the Institute.



Type of employing organization. More and more M.I.T. graduates—especially those with degrees from the School of Science—find employment outside of the private, profit-making sector.



Occupational roles of graduates of three M.I.T. schools. In this analysis, occupations are categorized by the roles they represent, independent of the underlying content area which is involved.



Income of alumni in different occupational groups. Presidents are clearly the highest paid, professors and staff employees of companies or laboratories the lowest. Occupations are listed in decreasing order of overall income for all three classes combined.

oldest of whom are primarily in the private sector, the youngest primarily in non-profit institutions. The younger science graduates seem to be following quite a different career line from their older counterparts; they are much more likely to go on to graduate schools, earn doctorates, and become university professors.

Most of the respondents work in large organizations, the only notable exception being that group who report they are company presidents: 72 per cent of these head organizations of less than 100 employees.

How Successful Are They?

A person's success in his work can be gauged objectively, by indicators such as rank or income, or subjectively, by his own evaluation of his accomplishments.

Looking first at income: 22 per cent of the respondents who graduated in the Class of 1951 are making over $30,000 a year, 42 per cent are earning $20,000 to $30,000, 26 per cent have salaries between $15,000 and $20,000, while 10 per cent are making less than $15,000. The proportions for the respondents in the Class of 1955 are similar, but we see the expected shift due to age in the Class of 1959, where 26 per cent are still earning under $15,000 and only 4 per cent are earning over $30,000.

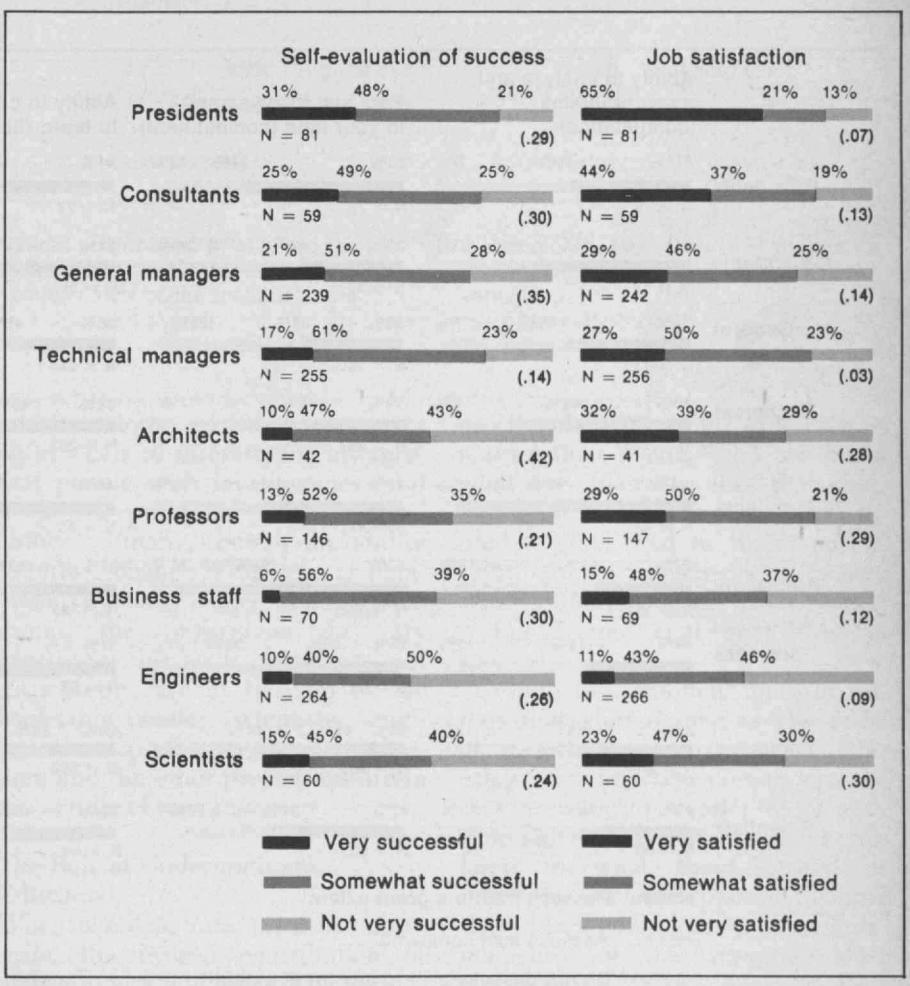
Income varies not only with length of time out of school but also with occupation. Presidents are clearly most highly paid, consultants and general managers are next, and architects and technical managers come next; business staff, engineers, scientists, and professors make up the bottom of the income distribution.

Income also varies with amount of education. Among technical managers, engineers, and scientists, higher income is associated with higher degrees. But the effect of occupation is stronger than the effect of education: managers with a bachelor's degree out-earn even the doctoral-level scientists and engineers. There is little in these results to support the claims of companies that they have a dual ladder for technical and managerial people. Thus it would appear that the way for an M.I.T. graduate to get ahead, at least as measured by income, is to go into management.

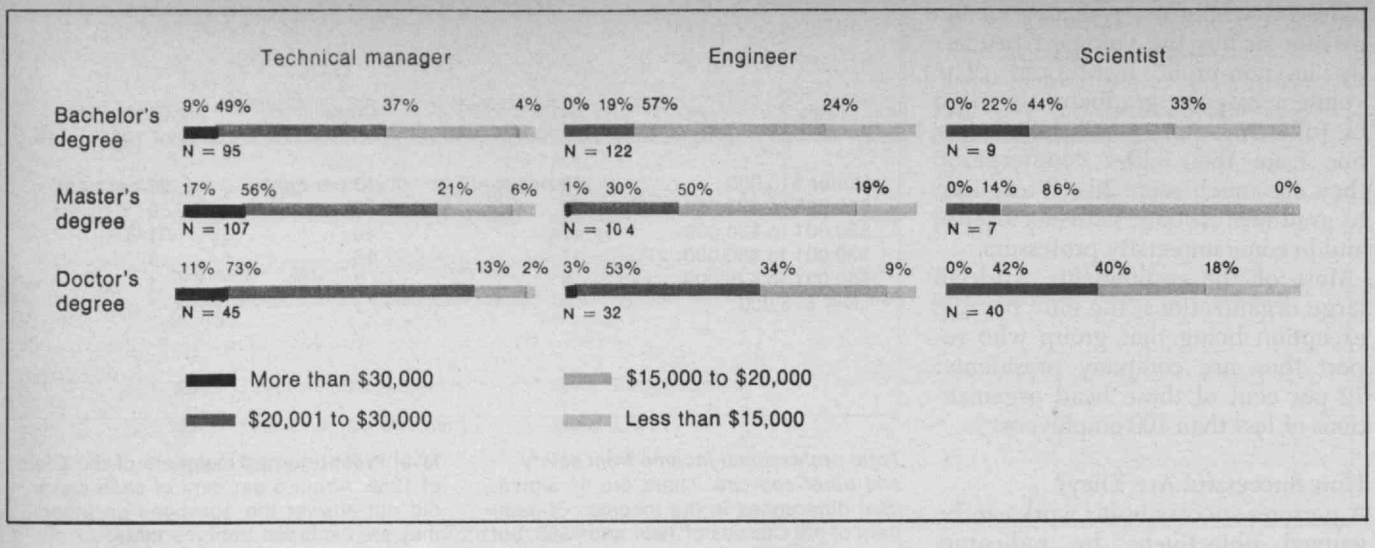
But income is not the only measure of success, and we know that people's subjective evaluation of their

Income	*Class of 1951*	*Class of 1955*	*Class of 1959*
Under $15,000	10 per cent	10 per cent	26 per cent
$15,000 to $20,000	26	33	39
$20,001 to $30,000	42	40	31
$30,001 to $50,000	17	15	3
$50,001 to $75,000	3	2	1
Over $75,000	2	1	*

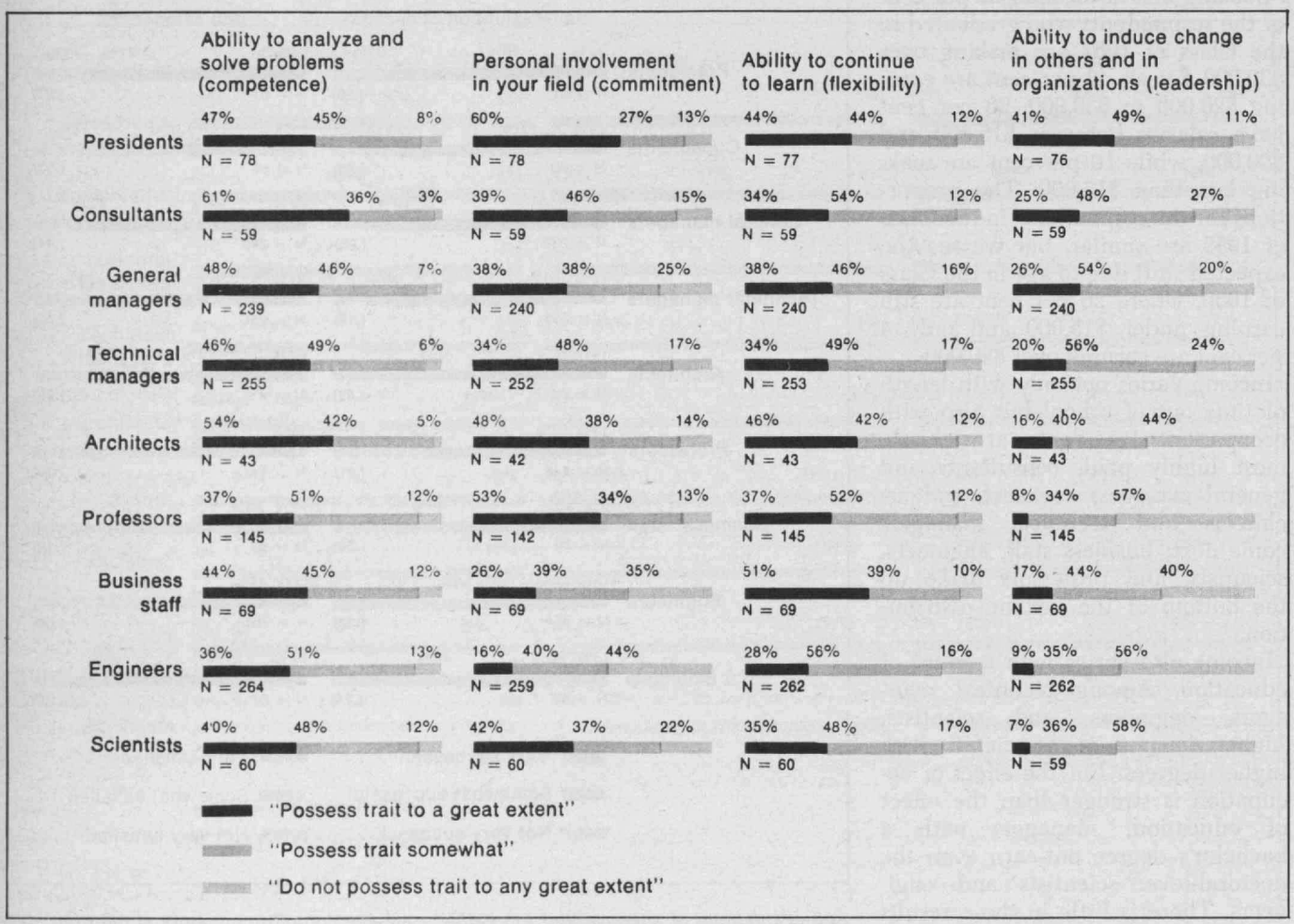
Total professional income from salary and other sources. There are no significant differences in the incomes of members of the Classes of 1951 and 1955, but, as might be expected, a lower income level is reported by members of the Class of 1959. About 5 per cent of each class did not answer the questions on income; they are excluded from the table.



Self-evaluations of success and job satisfaction in different occupational groups. Occupations are listed in the order of decreasing overall income. On the whole, the groups line up in much the same order on self-evaluation of success and job satisfaction. (The numbers at the right below each bar are the correlation coefficients between total income and self-evaluation of success or of job satisfaction.)



Income of alumni in three occupational roles with different levels of education. Though higher income is associated with higher degrees, occupational role is more important: technical managers with only an S.B. outearn even engineers and scientists with doctorates.



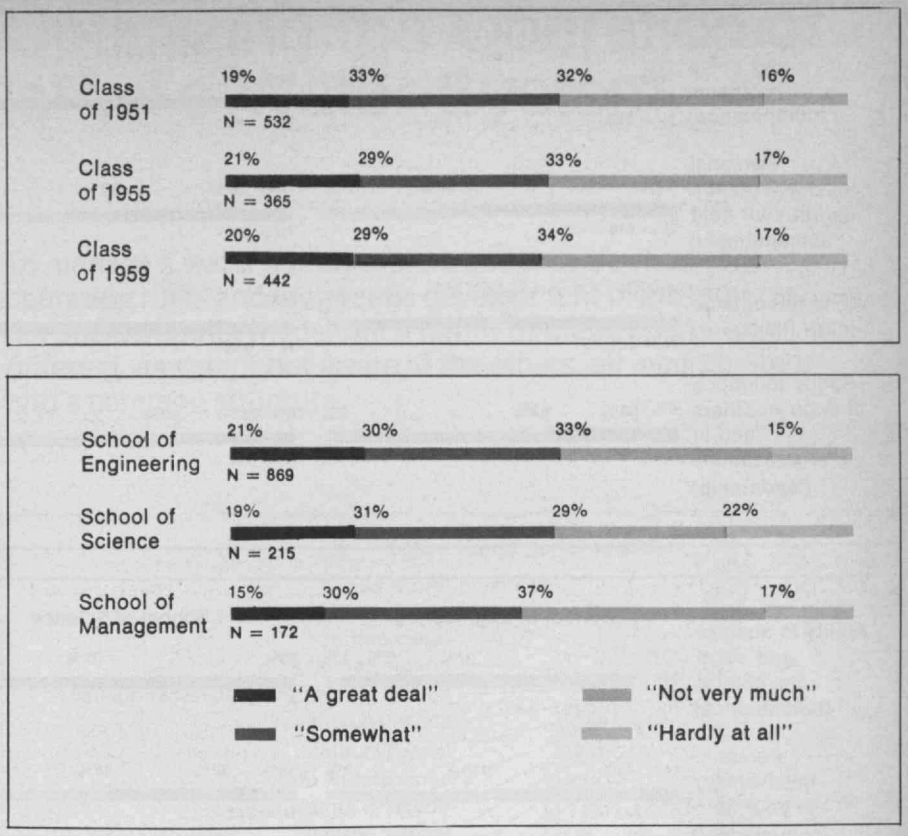
Self-assessment of four abilities and traits by different occupational groups. For each of the dimensions, engineers have very low self-assessments relative to other occupations. (Occupations are listed in order of overall income.)

work is not solely dependent on it. So we asked alumni to record their own sense of success in their work and the degree to which they are satisfied with their present jobs. On the whole, the groups do not line up too differently on these attributes than they do on income. It is of interest to note though, that the scientists, who are at the bottom of the income scale, are relatively high on the rank order of perceived success and particularly high on job satisfaction. Engineers, in contrast, reflect their position on the income scale by their low ranking on self-evaluation of success and job satisfaction. (The data are shown on page 37.)

If, on the other hand, we look at the relationship of income to perceived success for individuals within a given occupation, we find quite a bit of variation: in some occupations, like general management and architecture, the correlations between income and subjective success ratings are fairly high; in others, like technical management and the academic profession, they are very low. And, with the exception of the scientists, architects, and professors, the correlations of income to job satisfaction are close to zero.

Various professions, of course, require different abilities for the successful pursuit of a career within them. In some, basic competence is the critical factor; others depend more on a person's level of commitment to his work; still others primarily require leadership skills; and in some professional roles flexibility and receptiveness to new ideas are crucial elements. We asked alumni to indicate the extent to which they possess such abilities and traits, and the results, in conjunction with their occupational choices, make an interesting matrix displayed in the chart on the opposite page.

Some professions see themselves as primarily dependent on competence: general managers, technical managers, engineers, consultants, and architects feel their chief abilities are to analyze and solve problems. Presidents, scientists, and professors, in contrast, view commitment as more crucial; their highest self-assessment centers on the extent of their personal involvement in their fields. Only people in business staff positions put primary emphasis on the ability to continue to learn, perhaps because such positions are not seen as final career stages but as interim stops on various career paths (it is of interest, for instance, that people with low incomes tend to put a prime emphasis on this ability). Finally, though the ability to induce change is not seen as dominant by any one occupational group, the professions do vary greatly on this trait: presidents, not surprisingly, are at the top of the leadership scale; scientists, engineers, and professors are at the bottom; and the other professions are in the middle of the range.

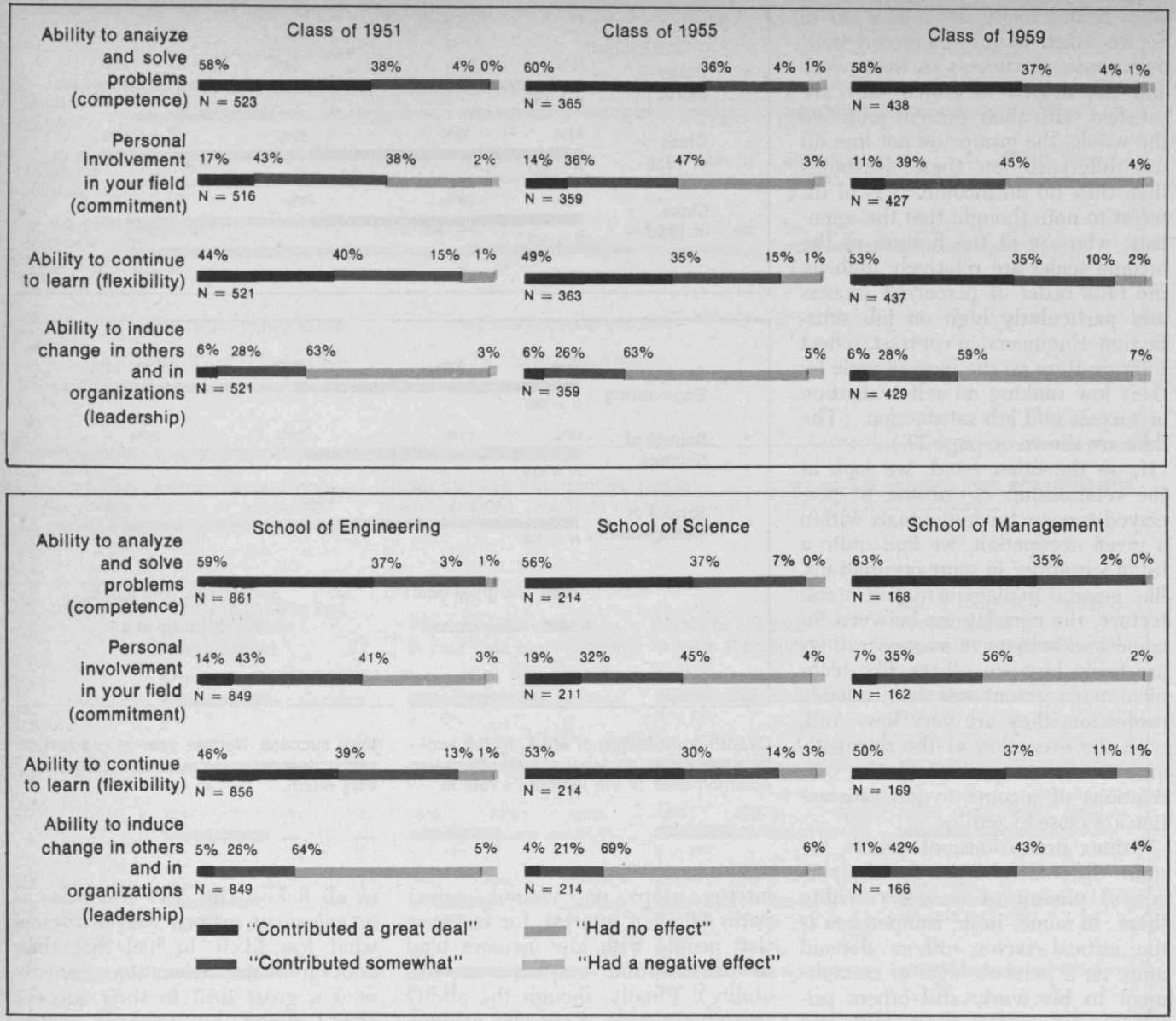


Overall contribution of M.I.T. to the success of graduates. Most alumni share a common view of the Institute's role in their success. Neither year of graduation nor undergraduate major changes this very much.

The Role of Undergraduate Education

When asked to rate, on a five-point scale, the overall contribution of their undergraduate education to their success in work, 20 per cent of our respondents gave it the highest evaluation ("a great deal"—5) and another 30 per cent circled 4. Only 17 per cent were critical enough of the relevance of their education to rate its contribution as "hardly anything"—1 or 2 on the five-point scale. These percentages are virtually the same in each of the three classes and among graduates in all fields. The only exception is management majors, who are somewhat less likely to feel that their undergraduate education contributed a great deal to their success. (But among management majors with *graduate* degrees from M.I.T., a full 31 per cent gave this response).

Despite the relatively uniform ratings that alumni give of the *overall* contribution of their M.I.T. education to their vocational success, they are able to identify those abilities and traits that are closely related to what they learned as undergraduates as opposed to those that developed more or less independently of this training. Most alumni, for example, relate to their undergraduate experience the ability to analyze and solve problems; most also attribute to M.I.T. the ability to continue to learn. In contrast, the ability to induce change in people and in organizations is not generally perceived to be related to one's undergraduate education, nor is one's personal involvement in one's field. These assessments do not vary much from one



M.I.T.'s contribution to the development of four abilities and traits. Most alumni attribute to their M.I.T. experience the abilities to analyze and solve problems and to continue to learn. They are much less likely to feel that M.I.T. contributed to their commitment to their fields or to their leadership ability.

class to the other; but graduates of the Sloan School of Management are less likely than other alumni to attribute their personal involvement in their fields to their undergraduate education and more likely to relate that training to their ability to induce change in people and organizations.

In conclusion, these data suggest an important issue for M.I.T.—and, by extrapolation, for other institutions undertaking technological education. It is this: alumni who are still employed as engineers a decade or more out of school (about one fifth of our sample) appear to be alienated from their work; they see themselves as less successful and less able, and are less satisfied with their field and jobs than other graduates in our sample. Future research might well focus on how M.I.T. can help resolve these frustrations by providing either opportunities for technical up-dating or training for career transitions.

Uri Shamir
Senior Lecturer
Faculty of Civil Engineering
The Technion

Optimizing the Operation of Israel's Water System

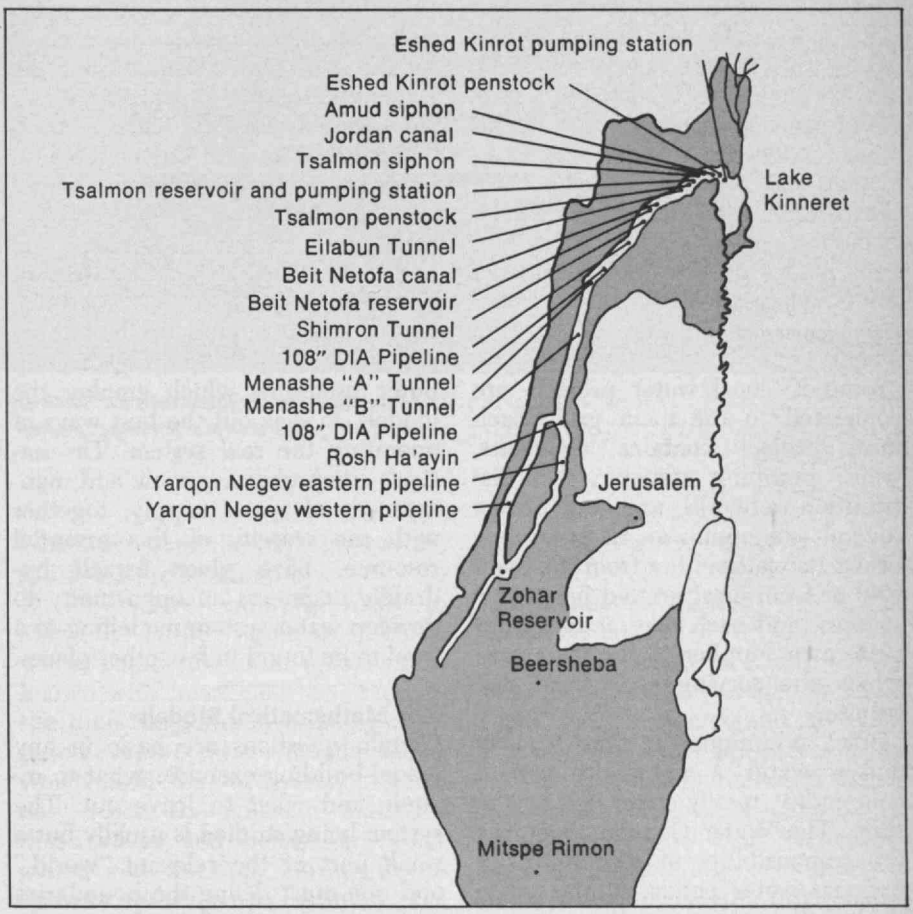
To manage a water supply system and provide short term operating rules and long-range development plans requires not one computer model but a family of them, each with a different viewpoint but aware of the others, all incorporated into a common structure.

It is commonly accepted by the experts that Israel is already using well over 90 per cent of the water available to it from conventional sources. In Israel water is a nationally owned commodity, the nation's water supply system is unified and centrally controlled, and its planning and management are a model of systems analysis and rational decision-making. How this is done will be the subject of this article.

Scarcity of resources is but one aspect of Israel's water problem. Most of the sources are located in the northern and central parts of the country, while much of the consumption is in the central and southern parts, making it necessary to transport large quantities of water over considerable distances. Some 85 per cent of the consumption is for agriculture, which results in high demand occurring simultaneously throughout the system during the warm summer, whereas rainfall occurs during four to five months of winter.

A warm climate, which enhances evaporation, combined with the absence of suitable sites for surface reservoirs, has led to the use of aquifers—water-bearing underground geological formations—as operational reservoirs. Water is put into storage in the aquifers during the winter and pumped out during the summer. An added complication is that the salinity of the water in the main surface reservoir, Lake Kinneret (also known as Lake Tiberias or the Sea of Galilee), is too great for irrigating some of the principal crops. This water must therefore be diluted in the aquifers with less saline native water before it can be pumped back out and delivered to consumers. It is necessary to control the rates and locations at which water from Lake Kinneret is pumped into and out of the aquifers in order to obtain the desired results.

All these considerations, combined with the predicted development of the country and its agriculture, are forcing the planners to consider unconventional sources of supply, such as reclamation of sewage and desalination. But here we shall look only at the way the operators of the existing



As the map shows, Israel's main water carrier branches into two pipelines at Rosh Ha'ayin, which later rejoin. Connected to the main carrier are the ground-water aquifers which provide both supply and storage, and about 25 local water projects with their own reservoirs and wells.

Uri Shamir, in addition to his work on the faculty of the Technion (the Israel Institute of Technology), is a permanent consultant to the national water company Mekoroth, where he is responsible for the work of a number of researchers in the systems analysis and computer-use fields. A graduate of the Technion, he obtained his doctorate in M.I.T.'s Division of Hydrodynamics and Water Resources, and remained at M.I.T. for a year as Assistant Professor in Civil Engineering. Much of his research has been devoted to the movement of water in aquifers.

water system attempt to use the naturally available resources in a prudent and efficient way.

The National Water System

Israel's water system centers around the National Water Carrier, designed in the 1950's and completed in 1964. The core of the system is a main carrier 130 kilometers long with pumping stations and operational reservoirs. The main sources of supply are ground-water aquifers, mainly along the coastline, and Lake Kinneret in the north. The Lake supplies each year some 340 million cubic meters (m.c.m.) out of the country's total consumption of some 1,500 m.c.m. It lies in the Jordan valley, 210 meters below sea level, and the first step is to lift the Lake's water some 370 meters to the Jordan canal. Thence, via further canals, tunnels and 108-in. closed pipelines, the system reaches Rosh Ha'ayin. Here the single pipe branches into two parallel lines which, further south, rejoin, and continue as a single line to the southern desert—the Negev.

Some 25 local water projects are connected to the main grid. Each local project contains reservoirs, wells, pumping stations, and distribution networks, and each serves several communities. Each project draws its water either from the main grid or from local ground or surface sources, and each may at times operate as a supplier to the main grid while also serving as a local distributor.

Israel is unique in that its law makes water a nationally owned commodity, totally controlled by the state. The Water Commissioner has the responsibility of formulating a national water policy; to this office is also given the power to carry out that policy. The Commissioner specifies the allocations to each consumer and the broad policy for the use of the water sources. Likewise a single company, the Mekorot Water Co., is charged with operating the main grid as well as all local projects. It operates within a general framework provided by the Water Commissioner and in accordance with contracts it signs with water consumers—communities or individuals, as the case may be. The contracts require Mekorot to supply specified monthly quantities with a specified minimum pressure head, and also cover other conditions, such as the maximum permitted daily consumption as a fraction of the monthly quantity.

Within the policy set forth by the Commissioner and the limitations of the contracts, the Mekorot Water Co. has considerable freedom in choosing how to meet these requirements. And if through research and cumulative experience the government agency and the company—jointly responsible for both short- and long-range operation of the entire water system—find better ways to do it, they are fully authorized to implement their findings.

The on-going work described here constitutes the basis of such progress. It is the result of a team effort by the staff and consultants of the Research Division of Mekorot Water Co. headed by Dr. Nathan Arad. The work is carried out in cooperation with the operators of the various parts of the water system, and the results of the work are implemented as they become available. Most of the planning effort is based on mathematical models of the supply system, and on the writing of computer programs which employ the models, to seek out the best ways of operating the real system. The nation's comprehensive view and management of water supply, together with the scarcity of this essential resource, have given Israeli hydraulic engineers an opportunity to develop water system modelling to a level to be found in few other places.

The Mathematical Models

Certain questions are basic in any model-building exercise: what to include and what to leave out. The system being studied is usually but a small part of the relevant "world," and one must define the boundaries and determine the "boundary conditions," which are the common ground between the computable system and the uncontrolled and largely unknown "rest of the world." In most cases these boundary conditions are not fixed in advance and depend at least to some extent on the behavior of the system under study: whatever we do, the rest of the world is likely to react, so that our next move is made in altered circumstances.

Furthermore, one often has to simplify the mathematical description of the real system, with the aim of making the mathematical model manageable. In general, the wider the horizons of the model, the more one must simplify the details.

On the one hand, we are dealing with the water system of a nation, and must plan many years ahead. On the other hand, we must provide operating rules for the smallest components, such as a pump or valve, a few hours in advance.

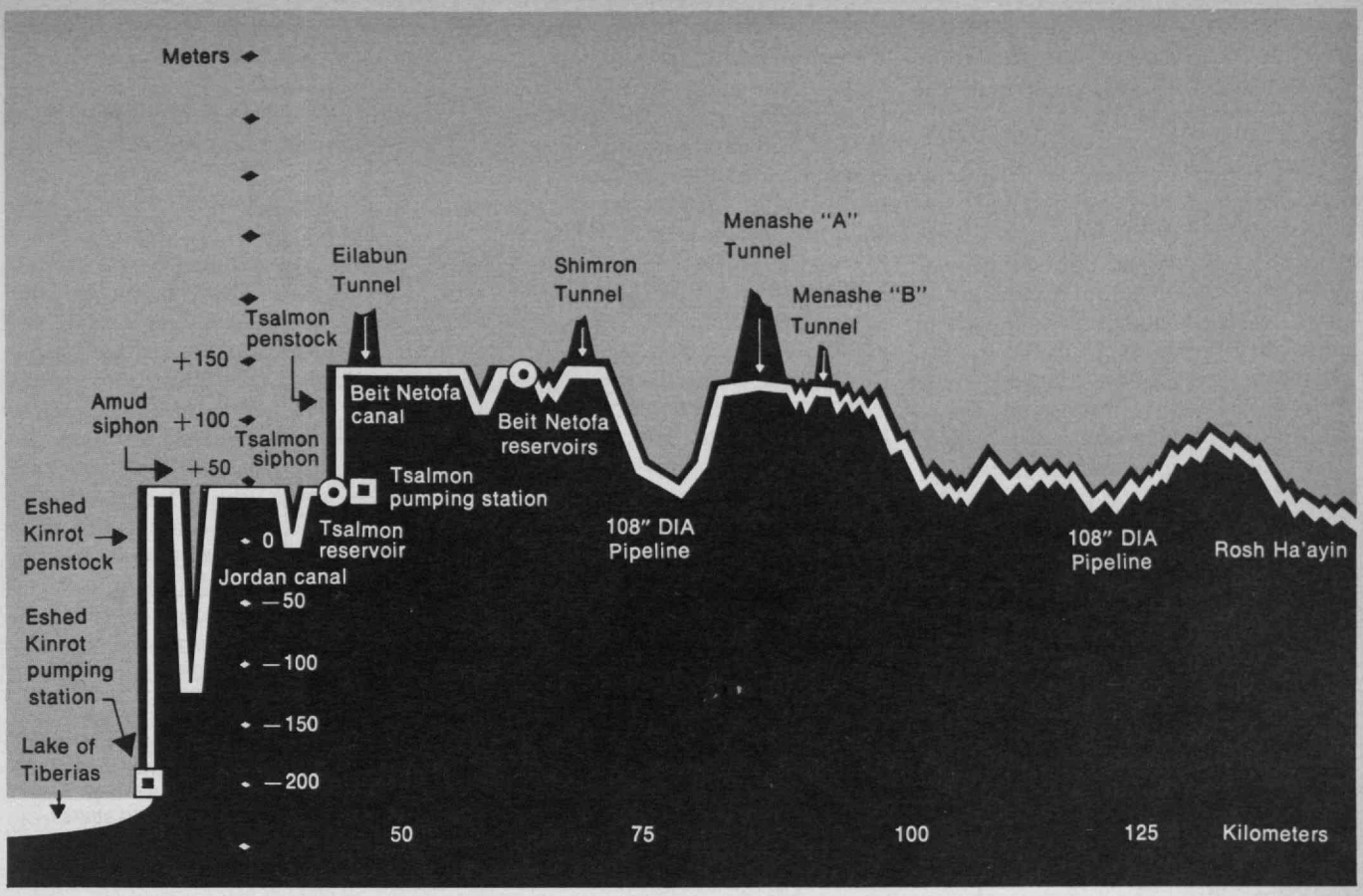
The traditional approach has been to make a model to deal with just one specific time-horizon, and to cover questions relating to events over much longer and shorter periods of time by making assumptions. The results obtained depend strongly on these assumptions.

The approach which has been taken in our work is to deal with all time horizons—each in a separate model—in such a way that the several models provide one another with information that is far better than mere guesswork. In other words, we are developing a "family" of models, all comprehended within a unified structure. The concept seems likely to be applicable to many kinds of practical planning problems. Because each model deals with a different time horizon one can view the models as being arranged in a *hierarchy*. The longer the time horizon covered by the model, the higher up it is in this hierarchy.

Our hierarchy of models comprises: a D(decades)-model of the whole system; a Y(yearly)-model of the main system; and a number of I(instantaneous)-models, one for the main grid (the IM-model) and one for each of the local projects (IL-models). The Y-model and the IM-model are in advanced stages of development, and results are being implemented as they are obtained. One IL-model—for a large local water project—has been completed and fully tested, and the results have indeed proved helpful in the operation of this project. Work on the D-model is still in the initial phases.

In order to describe any one of these models it is necessary to specify what it represents and what it is for. In fact, there is more to it than that; these models can be best discussed by following this eleven-point check-list:

1. *Content:* the part of the system with which the model deals.
2. *Time-scale:* the time horizon represented by one run of the model, and the intervals into which it is divided.



The core of Israel's water system is a carrier 130 km. long, from Lake Kinneret to Rosh Ha'ayin, comprising a series of canals, siphons, tunnels and pipelines.

3. *Outputs:* the types of decision which the model is designed to generate.
4. *Inner constraints:* for example, maximum and minimum permissible levels in reservoirs represented within the model.
5. *Detail constraints:* feasibilities, costs, and benefits dictated by the outputs of the next-lower model dealing with a shorter time-horizon and a more detailed description.
6. *Long-term constraints:* directives and long-range economic functions which are dictated by the next-higher model.
7. *Objectives:* for example, to minimize the cost of serving the consumers without compromising longer-term considerations.
8. *Frequency:* how often the model is used, and the urgency with which its results are needed when its use is required.
9. *Data:* description of the state of the system being modelled (which, depending on the level of the model, may be seen as changing very slowly or very rapidly).
10. *Optimization algorithm:* the procedure used to compute an output which achieves the objectives while satisfying the constraints.
11. *Parameters:* variables likely to affect the output (such as rainfall) whose values are either unknown, or known with insufficient accuracy, at the time the solution is being computed. These also include items which will be accurately known only when the adjacent models—those above and below—are completed and working. During development one has to estimate the values of the unknown parameters using judgment and the best information available, and then perform a sensitivity analysis, discovering to what extent their variation affects the model's output.

In describing the practicalities of the models, we may either work from the top down or from the bottom up. Either way, one cannot say very much about one model without bringing in the others, and the aim is to understand the whole hierarchy. Rather arbitrarily, we shall start at the nuts-and-bolts level of the one completed IL-model. We shall then look at the differences of approach that become necessary as the horizons widen out.

"Instantaneous" Model: Local System

The local systems in Israel vary in size, complexity, storage facilities, types of consumers, and so forth. Not all local water projects will justify the investment time and money needed for developing a model. At present only one local model has been completed and a number of other local projects are under study. The completed model deals with a relatively large system, called the Kfar-Baruch project, in which consumption is primarily agricultural. There is an 8-million-cubic-meter surface reservoir in which water both from the main grid and from local sources is stored. In relation to the main grid, the project always appears as a consumer, never as a supplier. The model can be analyzed as follows:

Content—The Kfar-Baruch project encompasses a main surface reservoir, nine operational surface reservoirs used for daily regulation, and ten booster stations.

Time-scale—The model covers one

day's operation, in steps of no fixed length—for purposes of calculation the important interval is the time between changes in operating conditions.

Outputs—In the reservoirs, pumps are controlled by set-points, and possibly by clock settings. In each booster station there are defined groups of pumps, called pumping configurations, each of which has a known capacity/pressure-head relationship. A configuration is switched on when the water level in its associated reservoir drops to a given set-point, and it is stopped when the level rises to another point. These points may be over-ridden by clock settings. The IL-model generates the settings of all these points for all the configurations in the local system.

Inner constraints—The requirements on the system as modelled are:

- ☐ All demands have to be met.
- ☐ Flows and heads in the network have to satisfy the physical laws of hydraulics.
- ☐ Water levels in all reservoirs must be kept within certain specified limits.
- ☐ There are also limitations on the allowable locations of set points, such as a minimum distance between adjacent points.

Detail constraints—Since the IL-model is the most detailed possible, this category does not arise; there are no constraints imposed "from below."

Long-term constraints—This IL-model, with others as developed, are to be used by the IM-model, which deals with the instantaneous operation of the main system and operates on a slightly longer time-scale. The connection between them, in the real world, is the transfer of water from the main grid to the local system and back. The IL-models therefore receive from the IM-model the amounts of such transfers during each period of time.

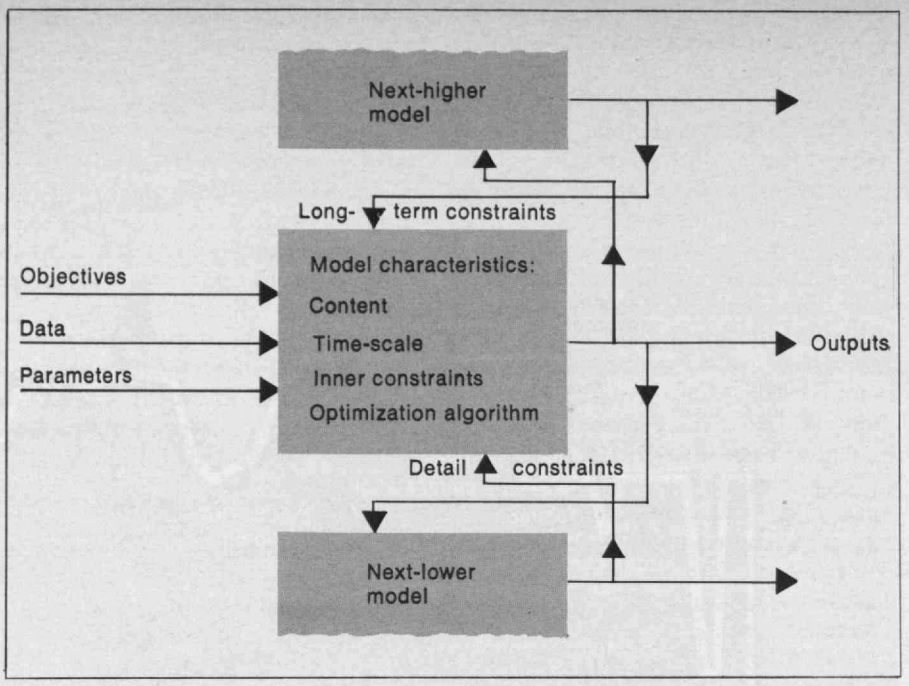
Objectives—Each IL-model is to be used principally to determine how to minimize operating costs. At present we measure these costs by the energy expended in pumping. Each configuration takes a certain amount of energy to operate, and the energy used in 24 hours is the measure for the efficiency of the chosen values of the set-points.

Frequency—Each IL-model is to be used in either of two possible ways: It can be used to study in depth the operation of the system, with the aim of obtaining operating rules for normal times and of determining the most economical response for dealing with emergency conditions; or it can be used routinely once every day or every few days to take care of changing conditions. At present it is thought that the IL-models will be used in the former mode. This means they will not be run on-line, and therefore one can if necessary tolerate long running times and a relatively slow response.

Data—It follows from what has been said that each IL-model will contain a full description of the hydraulic system, the hourly demands of all consumers (as determined by a prediction model which has already been implemented), pump data (capacity/head curves, energy consumption, etc.), and the current set-points (with the limitations upon their alteration).

Optimization algorithm—The complexity of the IL-models will preclude the application of any of the better known mathematical optimization techniques. We have resorted to a search technique, which is essentially a strategy for changing one or a few decision variables at a time, each time moving from one feasible solution to a better one. There is no guarantee that this strategy obtains the best possible solution, but experience shows that the solution it gives is satisfactory.

Parameters—As regards the unknown variables, the important thing is to discover how sensitive the solution is to variations in them, over their likely range of variation. The sensitivity of the first IL-model has been examined with respect to demand pattern (changes in the demand-peak's magnitude, duration, and timing during the day), storage volume in the reservoirs, number of operating pumps and their sizes in various booster stations, and the initial and required final conditions of the system as indicated by reservoir levels.



Israel's water system is simulated not by a single computer model but by a hierarchy of models, each responsible for a particular time-scale. The basic description is the same at all levels: what varies is the practical content of the terms used in this diagram. Each model provides information to, and draws information from, the model above or below it in the hierarchy. In this way a coherent simulation is built up which can give realism to decisions on all scales, from individual valve settings to national policy.

Instantaneous Model: The Main System

The main system has one long-term surface reservoir (Lake Kinneret), some 15 ground reservoirs (aquifers, or well-defined sections of aquifers), and five operational surface reservoirs used for hourly and daily regulation. The 25 local projects are each seen by the main system as demands, as points where water is transferred to or from the main grid or the reservoirs. In relation to the operation of the main

system, "instantaneous" has a slightly different meaning from the case of a local system—the *time-scale* simulated by one run of the IM-model is several hours, in steps of one hour.

Outputs—The model decides on the starting and shutting down of pumps, on reservoir levels, on valve settings, and so forth, thus dictating the discharges throughout the system and the hourly water transfers.

Inner constraints—Again, hourly demands to direct consumers must be met, and the laws of hydraulics must be taken into account. In addition, salinity cannot exceed a given maximum at certain points in the system.

Detail constraints—Although there is no model below, the IL-models should be used to determine whether "proposed" hourly transfers to and from the main grid are hydraulically feasible in the local projects. Alternatively, it is possible to include in the IM-model constraints representing the hydraulics of the connections to the local projects. Both approaches have been used, selecting the more suitable one for each connection.

Long-term constraints—Each month, quantities of water must be put in or taken out of storage, mainly in the ground reservoirs. These, computed by the yearly (Y)-model, become constraints on the IM-model. It is obvious that these transfers incur immediate costs (and the objective of the IM-model is the minimization of operating costs), whereas benefits from them will accrue only in the distant future. There must be some way of weighing the immediate costs of storage operations against their long range benefits.

It is not possible to do this within the IM-Model itself (because this would require running the model for a simulated period of one year, or even several years). Thus we introduce the long-range benefits in the form of constraints, forced upon the IM-model by the Y-model. (Incidentally, a complicating factor is that some water is lost through underground flow out of the aquifers, used for storage.) Rather similarly, monthly transfers to local projects, also dictated by the Y-model, must be carried out. The IM-model decides the best times within the month to do this.

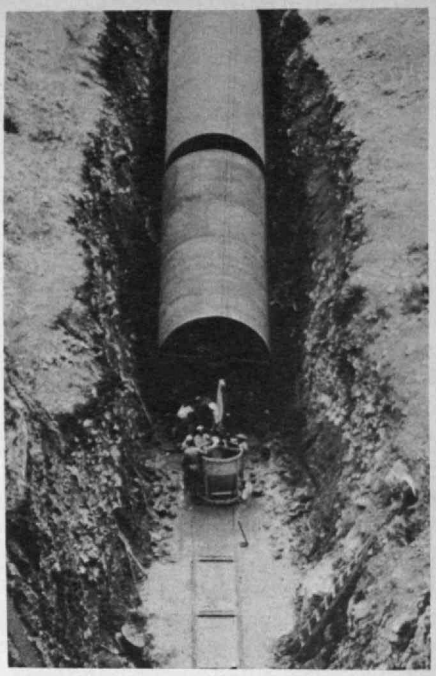
Frequency—Like the IL-models, the IM-model should be available for use either on-line, in real time, to control operations, in which case it would be run every few hours; or it could be used first to work out a satisfactory routine for manual operation under normal conditions and later for dealing with exceptional or emergency situations only. When each model is completed we shall know how much computer time is needed to run it and how much each solution costs. With this information, we should be able to reach a decision on the best mode of use.

Data—On-line operation of the IM-model in real time would require an extensive and very expensive data-acquisition system, covering reservoir levels, indications of pumps in operation, pressures, discharges to consumers, etc. If, on the other hand, the model is to be used off-line, then the data acquisition and dispatch problems are greatly reduced. We hope on the basis of initial results obtained from the model to determine the desirability of installing a high-speed data acquisition and dispatch system. A dispatch center for a section of the main carrier and several local projects connected to it has recently been completed. The experience gained in operating this part of the system with constantly updated information, together with the results obtained from the analytical work will help in deciding on the level of automation to be implemented. Either way, a data base giving the full description of the system has to be resident in the computer (or in secondary storage).

Optimization algorithm—The many decision variables and constraints, the complexity of the system, the wide variety of feasible solutions, the large number of times the model is to be run, and the urgency with which the solution is needed, all put severe limitations on the selection of an optimization procedure. For purposes of computation we have divided the network into four parts. For each we use a dynamic programming formulation, together with some heuristics aimed at simplifying the computations. The individual solutions, obtained separately, are combined to obtain a solution for the entire system.

The Yearly Model

The Y-model deals with the main system—that is, the overall *content* of the model is as already described—with the difference that the configuration may change from one year to the next as modifications and additions are implemented.



This photograph was taken looking down the near-vertical cutting prepared for the 3.65-m. pipes of the Tsalmon siphon. The pipe sections shown are resting on a track laid in a horizontal cutting at the foot of the Tsalmon wadi gorge.

Time-scale—The year is divided into steps of one month. Within the model, separate blocks each define the operation during one month, and there are equations which connect these blocks together.

Outputs—The model tells us the quantities of water to be transferred during each month from point to point in the system—the amounts to be taken from the surface and ground reservoirs, amounts to be transferred from or to all local projects, and the monthly quantities passing through each line of the main grid.

Inner Constraints—As with the instantaneous models, it is mandatory that all demands be met, that flows be hydraulically feasible, and that, at certain points, salinity is kept within given limits. In addition, there are maximum possible yearly withdrawals from each source, determined by hydrologic considerations, and there are hydrologic, engineering and institutional limits upon the permissible levels in each surface and ground reservoir.

Detail constraints—The IM-model and the IL-models should determine whether a policy selected by the

Y-model for any month can indeed be implemented. The salinity and hydraulic constraints, in particular, cannot be treated with complete realism in the Y-model, which therefore uses simplified working versions of them and then relies on the IM- and IL-models for a detailed check on the resulting solutions.

Long-term constraints—Eventually, the long-range economic rules will be handed down by the D-model. For now, they have to be formulated by other means and their consequences examined parameter-style.

Objective—The Y-Model seeks to minimize yearly operating costs. Just as for the instantaneous model of the same system, the cheapest way to meet this year's demand is to deplete long-term storage. We know that recharge into the aquifers must be part of the best policy, else future demands would not be met.

To force the one-year model to produce a solution which takes this into account one can do one of two things: either specify, as "long-term constraints," the amounts to be put into storage in the aquifers; or incorporate into the formulation of objectives a positive value for any amount in storage at the end of the year, so that the model will seek to optimize not merely costs but a function combining costs and benefits of storage.

Either way, an output from the D-model is needed to provide a numerical value, but lacking the D-model it is easier to use the "constraint" method. One consequence of doing it this way is that, in the output of the Y-model, we then find "shadow prices" for the constraints, which are measures of how relevant these constraints are.

Frequency—The Y-Model will probably be run a few times a year (whenever actual hydrologic or other natural conditions differ significantly from what was assumed at the time the last solution was computed).

Data—At this model's level of analysis, the description of the system is largely permanent; some data change infrequently, some are periodic, but all can be acquired by simple means, and no on-line acquisition is contemplated for use with the Y-model.

Optimization algorithm—The model was formulated as a linear programming problem. A standard computer program is being used which is efficient and comprehensive. It is easy to perform parameter-variation runs, using the above-mentioned concept of shadow prices to bring the variations to comparable economic terms.

The Decade Model

The highest model in the hierarchy brings us to the realm where engineering meets national development policy. Work on the D-model has to date covered only the design phase —actual implementation is still only at its beginning. Therefore what follows is not considered to be the final form of the model.

The D-model deals with the entire system, not only in its present form but as it may be developed and expanded. The system is described in a schematic form only—for example, a regional water project, or several such projects, may appear as a single consumer. The *time-scale* is from several years up to a few decades, working in steps of at least one year, possibly several years. At present it is thought that the Y-model will be the building-block for the D-model.

Outputs—We expect two kinds of answers from this model: those relating to the operation of the system, in the manner indicated already; and those which contribute to planning the development and expansion of the system—for example, exploitation of new sources (conventional or man-made), augmentation of storage, or additions to the distribution system.

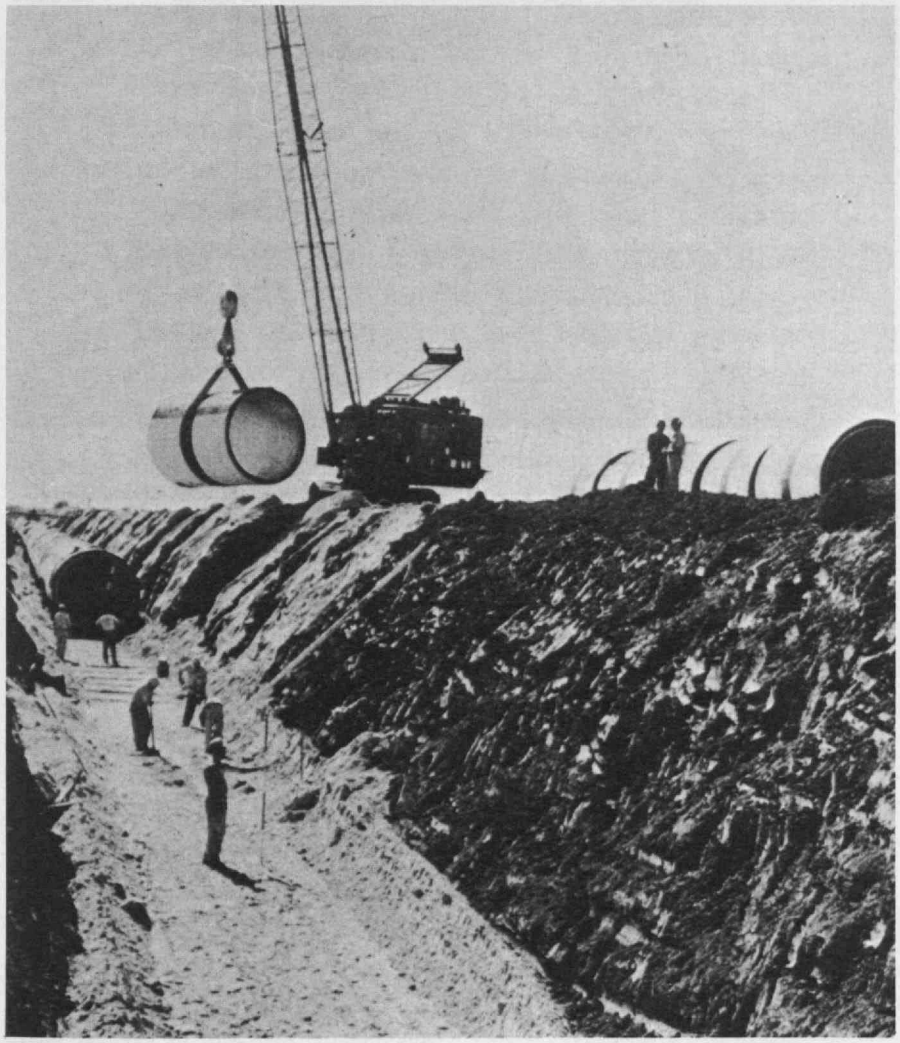
Inner constraints—The hydrology of the system limits the amounts of water which are available for use during any period of time. Viewed in the long term, the hydrology is stochastic (i.e., governed by unpredictable variations) and has to be treated as such in the model. In semi-arid regions the frequency and severity of droughts is probably one of the most important characteristics of the hydrology, although the entire sequence of stochastic yearly flows into all water sources has to be considered. These contingencies are modelled either explicitly (inserting probabilities) or by estimation followed by sensitivity analysis.

Another class of constraints is economic. Some of these are determined by the availability of capital, labor, etc.; others are given as directives by those at the helm of the national economy.

Detail constraints—In the manner already outlined in connection with the lower models, the Y-model is used to determine whether any policy dictated by the D-model can indeed be carried out. If so, the Y-model will also yield the cost (or benefit) of carrying it out in the optimal manner.

Objectives—Here a question arises: What should we attempt to optimize? We might either consider water as just one of many national resources, and set out to optimize some more general national economic goal; or we might consider the water system as a production

A 17-km. canal, at the sytem's highest altitude, crosses the Beit Netofa Valley. It was constructed with equipment specially built for the project in the U.S.; photograph shows the lining of the canal with asphalt prior to placing the concrete lining.



From the Beit Netofa Valley to the Rosh Ha'ayin junction, a distance of 77 km., the water is carried by a 108-in. pipeline. Photograph shows the laying of the 30-ton prestressed concrete pipe sections.

system in itself, designed to "produce" water and sell it. In this case the objective is to maximize the net benefit to the owner of the water system. The latter is the easier of the two approaches—the water system becomes a separate "industry" in the national economy, although tied to other industries, such as agriculture, by the prices it can obtain for the water sold.

But this does not represent accurately the conditions in Israel, where national authorities control the water supply company on the one hand and agriculture (through regulation and subsidies) on the other. So the first alternative is chosen.

Data—The data base for the D-model will be developed from the data used in the more detailed models, selecting only what is necessary for the schematic definition of the system. Hydrologic and meteorologic data will be updated every few months or every year.

Optimization algorithm—Here the basic philosophy is different from that of the lower levels. Over the period of interest, the hydrology, the meteorology and the demand are all subject to unpredictable variations. No mathematical optimization algorithm, it appears, will be suitable for solving the D-model, so rather than having the model itself seek optimum solutions we shall probably use it to reveal the consequences of humanly chosen strategies. In any case, the development of new, unconventional sources of supply has to be considered. This makes it difficult to formulate the D-model in a definite and final form. It will have to be used in various forms, to test, by simulation, proposed developments or technologies.

A Process of Adjustment

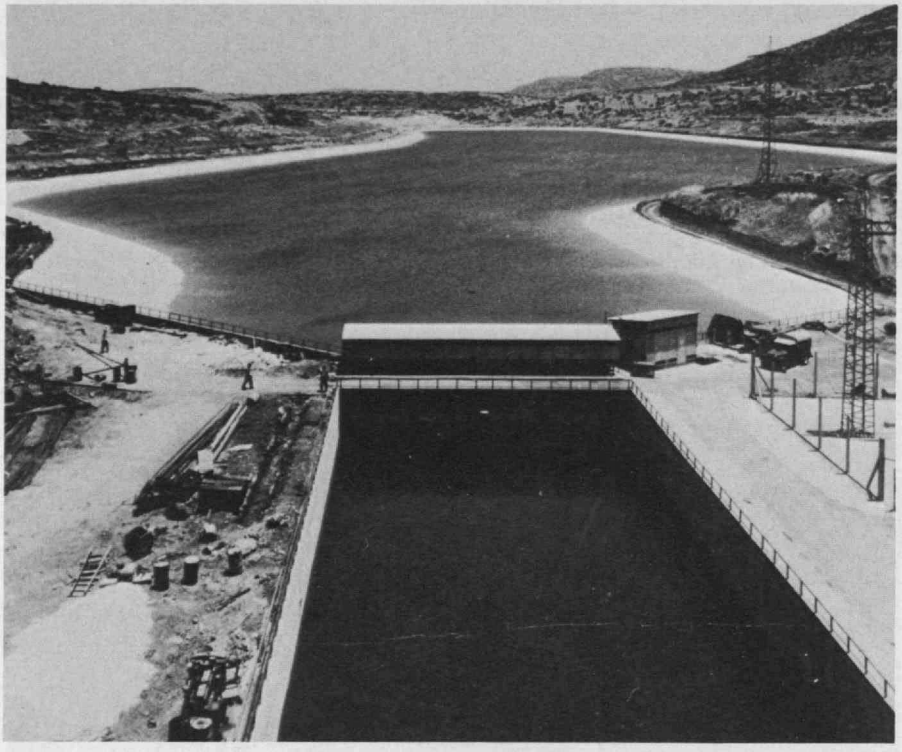
Development of the hierarchy of models as a concept and as a working tool is carried on at the same time that the individual models are being worked on. The general structure and some of the rules of the hierarchy were set in advance, to make sure that the models fit together. But things keep changing in the progress of the work. This is normal and sound, but it does cause difficulties, as each model has to be adjusted to "meet" the neighboring models. Furthermore, each model needs some of the results from the other models. These are often not available at the moment they are

needed, and one has to substitute informed guesses, proceed with the development, and provide enough flexibility to incorporate new results as they become available.

A further difficulty arises from the fact that we are dealing with concrete, real systems. The models cannot be abstract, but rather have to incorporate all the "real world" practicalities of operating the systems. Such things as the lag between the occurrence of events and the acquisition of the data describing them, the operators' levels of competence to execute complicated policy rules, and the like, have all to be considered.

From this experience we are certainly learning how to attack complex problems in water resources. The progress to date encourages us in thinking that the approach we have taken is a promising one—the approach, that is, of decomposing the system in a physical (rather than mathematical) sense, dealing with each sub-problem separately after taking due consideration of its particular structure, and building the individual models so they fit together into a general structure.

Some immediate benefits are being derived from the work. The individual models are already being used by the operators of the system to study it in detail under various conditions and to test proposed operating rules and their physical and economic consequences.



This is one of the two main artificial surface reservoirs, the Tsalmon Reservoir, in process of being filled with water drawn from Lake Kinneret at the completion of the entire National Water Carrier.

Joseph F. Coates
Office of Exploratory Research,
National Science Foundation

Non-Lethal Police Weapons

Police forces have a continuing need for equipment whereby individuals or crowds can be controlled without needless and unjustified injury or death. But such progress as has been made has been the product of military, not police, research and development.

The individual policeman in his day-to-day operations has an urgent need for new weapons. If our society is to outgrow the habit of summary justice in the streets it must create and employ more benign methods than the traditional police weapons. Firearms and the nightstick fall far short of the reasonable demands for effective nondamaging weapons implied by, for example, the President's Crime Commission of 1967.

That commission recommended that all forms of deadly force be restricted to those occasions in which a life is at risk or serious injury is threatened, or where such a crime is known to have been committed. If that recommendation ever becomes general practice it will create a major demand for alternatives to firearms.

The traditional doctrine across the U.S. allows the use of firearms against fleeing felons when other means of apprehension have failed. That tradition is inadequate and unjust, since many crimes officially classified as felonies (such as auto theft, burglary, and resisting arrest) do not carry the risk of capital punishment: we have what might be called sledge-hammer-and-nut behavior. Misdemeanors—that is, less serious crimes—present a policeman with a problem in trying to apprehend a suspect. The nightstick, while useful, is dangerous and limited in range. Should the misdemeanant choose to flee, the officer until recently had no alternative except to give chase. The increased concern about rising crime rates, coupled with a general drive away from summary justice on the streets, has created a demand for new weapons.

This article will review some recent developments to mark what progress has been made, and what research and practical opportunities are still before us.

The Trends Since 1965

The use of tear agents in all forms of police conflict is now readier, more frequent and more lavish than it was a decade ago. A major stimulus to the widespread use of tear gas was the Omnibus Crime Control and Safe Street Act of 1968, which made millions of dollars in federal money available to the states for general improvement of their criminal justice systems; of which a disproportionate share has gone to the police, to the detriment of the courts or the parole and rehabilitation systems. The first order of business for the police was to increase their immediate capabilities for dealing with violence. That meant the procurement of a wider range of lethal and non-lethal weapons. Now that the first wave of purchases has met the needs perceived as most acute, the pattern in the use of federal money may shift to longer-range programs and nonviolent alternatives.

There are some 40,000 independent police jurisdictions in the U.S., ranging all the way from one-man police departments to the New York City department of over 30,000. Traditionally, this police non-system has sponsored virtually no research or development to identify and meet its needs. As a corollary, there is little in the way of testing, evaluation or establishment of standards. Innovation, whether good or bad, propagates slowly. Opportunities for new development through research go unrecognized. Weapons research, conducted on very slim budgets, has largely taken the form of speculative endeavors by commercial organization serving an uncertain market. As a result, new materials are frequently introduced on a shockingly slim basis of evidence as to their effectiveness, reliability or safety.

Accompanying the wider use of tear gas is a major trend away from the traditional tear gas C.N. (alpha-chloracetophenone) to the new agent C.S. (ortho-chlorobenzylidenemalononitrile). The switch has occurred largely at the instigation of the Army, which several years ago phased out C.N. in favor of the newer, more effective, safer, and more aggressive C.S., which has been so very generously used in Vietnam. Logistics, convenience and economy make a single standard agent most desirable.

Another major development is the use of chemicals by criminals. Over one hundred crimes have been committed by men armed with chemical projectors. Whether this is a step down in violence by those who would otherwise use firearms is unclear.

A final dominant trend with regard to chemical weapons for law enforcement is the proliferation of

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training materials, field demonstrations, and practical courses in the use and handling these weapons. Most of this is supervised and sponsored by federal and state authorities. In the longer term, such courses may facilitate other innovations in police arms.

In non-chemical weapons, the trend is confused and uncertain. A large number of weapons and concepts have been proposed, some prototypes have been developed, and after some test and evaluation a few have been put on the market. Perhaps the most interesting of these new devices rely on injecting drugs, on non-penetrating mechanical impact or on electrical effects. I shall consider non-chemical weapons at greater length after taking a closer look at the dominant growth area, tear gas.

C.S. and C.N.

In fact, neither C.S. nor C.N. is a gas. Each is a moderately high boiling, high melting crystalline solid. The older agent, C.N., was discovered in 1869. Following World War II it became, if not popular, at least standard and useful to police throughout the world. The newer agent, C.S., gets its abbreviated name from the initials of B. B. Carson and R. W. Stoughton, who invented it in 1928. It did not come into general police use in the United States until it was introduced to the world by British forces in the civil disorders in Cyprus in 1961.

The two dominant considerations in regard to the use of riot control agents are safety and effectiveness. Both agents earn good marks on these counts. (Incidentally, perhaps I should mention at this point that the seven members of my own family have, between us, experienced tear gas seventeen times on eight different occasions, while going about our lawful middle-class pursuits in Washington, D.C.) In some 50 years since the end of World War I, only five deaths have been reported in the United States from the agent C.N., and each was under unusual circumstance in which the victim remained for an incredibly long time in a room in which a large amount of tear gas had been distributed. There have been no civilian deaths reported from the use of C.S. in the United States. At the concentrations in which it is used, each of these agents is quite safe, although the margin of safety clearly favors C.S. The safety factor (the ratio between the dose effective against 50 per cent of the population and the dose lethal to 50 per cent of the population) is 700 for C.N., and somewhere between 1600 and 10,000 for C.S.

The effects of the agents are comparable, although those of C.S. are more severe. Both cause a burning sensation to the eyes and a heavy flow of tears. C.S. is more likely to force the eyes to close. It causes a burning sensation and stinging of moist skin, and the higher concentrations cause blisters. Each irritates the nose and increases salivation. C.S. has the further advantage of irritating the respiratory tract, causing tightening of the chest, coughing, and at some concentrations a feeling of suffocation and panic, but not accompanied by any severe physical damage to the lungs. The personal panic or alarm caused by C.S. can be quite significant in mob dispersal.

There are numerous systems for delivering either agent: dispersal from a burning source; as a preformed powder; in solution; as a fog. The two agents differ substantially in their persistence in the environment: the higher vapor pressure of C.N. presents less need for decontamination of affected areas: C.S., having a lower vapor pressure, persists longer. Indoors, C.S. can present a serious clean-up problem.

The traditional weapon for dispersing tear-gas agents is the grenade. There are two basic forms—with numerous variations on each—the beer-can grenade and the baseball grenade, each named for its shape. Risks are associated with each of these grenades even in ordinary use. The pyrotechnic grenade, which relies on the burning of a fuel, often presents a substantial fire hazard, as do the bursting grenades, which may also injure the eye with flying fragments.

Grenades, particularly the beer-can grenades, may be fired from a special launcher, or with an adapter from conventional firearms. Alternatively, range and accuracy may be achieved with other devices, such as cartridges and projectiles. Such projectiles may inflict serious injury if they hit a person, but that is not their intention.

The grenades and cartridges, while versatile, are often tactically inadequate on two grounds. The first is their inability to deliver small directed quantities of tear gas safely at close range. The second is their inability to deliver large amounts of tear gas cheaply, conveniently, and rapidly at close or intermediate range. Each of these shortcomings has been met in separate ways. The chemical wand, for example, dispenses 16 g. of tear agent over a period of four or five minutes. It is recommended for use against small groups close up.

At the other extreme, the Pepper

The trend in non-chemical weapons is confused and uncertain. Perhaps the most interesting new devices are those which rely on injecting drugs or on non-penetrating mechanical impact. But the dominant growth area is still tear gas.

Fogger is a dramatically effective device for dispensing large quantities of tear gas at close or intermediate range. It weighs 19 lb. empty and 27 lb. full, and will dispense either C.S.,C.N., or an inert fog at a rate of 0.7 gal./h. This gasoline-operated device uses a resonant-pulse jet of hot gases at high velocities to atomize rapidly a liquid formulation of tear agent—rapidly enough, that it is claimed, so that thermal breakdown is negligible.

The conventional insecticide blower has been adopted for military use in Vietnam under the name Mighty Mite. It is now available for civilian riot control. Other high-delivery-rate dispensers may be mounted either on trucks or in helicopters. These last are bulky and cumbersome, and have not achieved great popularity in civilian applications. Powdered C.N. or C.S. may also be dispersed in specially modified dry-powder fire extinguishers.

Micropulverized C.S. is available in two forms: as is, and treated with a waterproofing agent which increases its persistence, and thus in many applications its effectiveness. A cloud of waterproofed C.S. will be kicked up by people walking in the street or grass on which it has settled.

But the major innovation in routine police weaponry since the introduction of firearms is the liquid-stream projector. Dry-agent dispensers have been available to police officers for many years for personal self-defense and offense. They generally operate by the explosive dissemination of a pre-pulverized material. They have serious drawbacks: first, there is the intrinsic risk of physical injury, especially blinding; second, the cloud often engulfs the user as well as the victim; third, they do not repeat. They have enjoyed limited popularity in the civilian market for self protection, and among detectives and undercover men who need an unobtrusive device.

Under the stimulus of developing a safe and reliable weapon for his wife, one engineer hit upon the idea of putting tear-agent gas into solution and dispensing it from a spray-can. With the dispensing technology at hand, the problem became one of finding an appropriate solvent which would not increase the hazards of the agent, would be stable, and would be relatively safely dispensed not as a spray of droplets but as a stream. The net result of this research was the Chemical Mace, a small spray can containing a 0.9 per cent solution of agent C.N. in a mixed freon/hydrocarbon solvent. When the button is pressed a stream is projected up to about eight feet. The standard six-ounce device is said to shoot up to 40 one-second bursts, each of which should deliver approximately 0.25 mg. of the agent.

Being a stream rather than a spray, the agent can be closely and carefully directed at an individual target or succession of targets, three hoodlums for example. Ideally it should be directed not at the face but at the chest and torso, where the solvent will evaporate and rise up to affect the eyes. It is recommended that the device not be used closer than two feet because of the greatly increased risk of permanent eye injury. After use the victim should be given an opportunity to wash. In a severe case he should be given medical attention. A smaller pen-size version of the Chemical Mace is available to carry in purse or pocket. It is also available in the handle of a dual-functional nightstick. The same product is sold to civilians under

This smoke generator is advertised as "smoking rings around an arsenal of tear gas grenades." Its capacity is sufficient for 10 minutes of continuous release of irritant or inert smoke, producing "thousands of cubic feet per minute." Weight: 25 lbs. (Photo: General Ordnance Equipment Corp.)

another label and in a different can.

The simplicity and clearcut value of the liquid stream projector is testified by its rapid widespread acceptance. Since 1967 I estimate that over half a million have been sold. Considering this large number, it is rather surprising that there have been only 26 litigations or court actions concerning the police use of these weapons. Some 327 temporary injuries and one permanent injury have been reported. The liquid stream projector is filling a need in day-to-day police operations in which the policeman is required to subdue a resisting, threatening, or violent person whose behavior does not justify the use of firearms, and where the use of the nightstick would be either infeasible or risky to the victim or the user.

It might be worth noting in passing that in any given year about 10 per cent of police officers are assaulted in the line of duty. The projector should have a profound influence in reducing this occupational hazard. The chemical projector seems adapted to many of the established uses of the nightstick while overcoming some of its shortcomings and hazards. There are no codified data on the number of injuries from the use of the nightstick, their extent, or their sequalae, but it is generally recognized in police circles as a potentially dangerous weapon. Current neurophysiological theory and observation suggest that any blow serious enough to cause concussion or loss of consciousness is likely to cause irreversible damage to the brain. The great redundant capacity of the brain often obscures or overcomes the damage.

Police Research

The evolution of the Chemical Mace illustrates some inherent deficiencies in the U.S. police system (or nonsystem). Being so decentralized and uncoordinated, it lacks experience and competence in research and development on its own needs and operations. Chemical Mace, since its introduction six years ago, has continued to gain popularity and has stimulated a dozen or more competitive projects. It has also spawned an ample anecdotal and conjectural literature with regard to its physical risks and misuse (the latter attributed variously to prejudice, vindictiveness, carelessness, ignorance, brutality, or political motivation).

Studies have shown that the formulation may permanently injure the eyes of test animals. A report in late 1968 from the city of Berkeley, California, summarized a Public Health Service report on twelve cases of chemical burns to the cornea. All these sufferers recovered full vision in two days to three weeks, although three had second-degree burns of the face, which includes blistering. The report noted that in each case the weapon had been used improperly, at very short ranges—six inches to two feet. An earlier study from the California Department of Public Health reported on twenty-two policemen and one fireman injured by liquid-stream projectors or related devices. In seventeen of the cases, no time was lost from work. The maximum loss was seven days. The U.S. Food and Drug Administration has reported some risks in the use of the weapon, while the Army found the commercial liquid-stream C.N. projector too risky for its use, and went on to develop its own, with C.S. as the active agent.

On the other hand, at least two Presidential Commissions have advocated comprehensive and systematic programs to develop non-lethal weapons. In spite of the existing partial information, incomplete studies and numerous allegations, a comprehensive evaluation of the liquid-spray projectors has not been made. That evaluation should include the risks, the operational effectiveness, the operational hazards, technological and administrative safeguards, the extent and types of abuse and improper employment, and the device's utility and effectiveness in contrast to the alternatives.

It is ironic but typical that the United States, the most techologically advanced nation in the world, with its Gargantuan complex of research and development facilities, has found no state, private, federal or industrial organization able or willing to undertake what is a relatively straightforward program of research, development, test and evaluation of this class of weapons. Until this systemic organizational difficulty is overcome, progress in non-lethal weapons will continue to be spotty, uncertain, risky, and only partially effective. And our fellow citizens will be needlessly killed, maimed or brutalized in the name of law and order. A significant move in the needed direction may be the recent award of $25,000 to the United States Army Limited Warfare Laboratory by the Law Enforcement Assistance Administration to test and evaluate police weapons.

The Army's liquid-stream projector, based on agent C.S., uses a trioctyl phosphate solvent. The Army formulation is also available in a larger dispenser with a 30-ft. range and a 12-sec. firing time, resembling the familiar back-packed portable flamethrower. The relative effectiveness

The U.S. police system is so decentralized and uncoordinated that it lacks experience and competence in research and development on its own needs and operations. Chemical Mace, for example, has "spawned an ample anecdotal and conjectural literature" on use and misuse.

and overall advantage of the C.S. agent in liquid stream projectors, as compared with the agent C.N., is still in need of explication. Some argue that, because of its lower volatility, C.S. in solution is so slow to evaporate that unless it directly contacts the eyes it is less effective than the C.N. formulation.

Other applications for tear agents have been proposed for civilian police or riot control but not yet brought into practice. One interesting notion is to incorporate the tear agent in a stable water-based foam which could be generated rapidly in large quantities. In riot and mob control it could be used to quickly block streets or intersections. One proposed advantage would be a reduced manpower requirement for blockades. It would be a self-administering weapon: the tear agent in the foam would stand there doing nothing until someone attempted to penetrate. The technical and administrative issues to be studied in relation to this use should be obvious.

Injector Weapons

The injection of drugs into a person who must be apprehended has generated much public but relatively little scientific or police interest. The basic difficulties center around two factors: first, the size of dart which may be accurately and reliably fired at a target, so as to inject its material rapidly and safely; second, the choice of a drug which will be quick acting and safe over a relatively wide range of size of target, from a 90-lb. boy to a 240-lb. man.

There is an intrinsic limitation on the speed of action of drugs, which results from the fact that they are not likely to be injected at the site of biochemical action. For example, a drug injected by a missile into an arm, the back, a leg, or a buttock must generally find its site of biochemical action in the central nervous system. Since it is almost certain to be injected into fatty tissue or muscle rather than directly into a blood vessel, it must first diffuse into the blood and build up in sufficient concentration there, and then be carried by the blood stream to a site of action, where again it must diffuse until it reaches a sufficient concentration to do its work. It is intrinsically unlikely that the concentration required to incapacitate could be realized in less than a few minutes.

As a rule of thumb it should also be noted that the more rapidly acting drugs—that is, those effective in the lowest concentration—tend also to have low safety factors. Low safety factors mean that it is dangerous to fire several darts into one person, or to fire a dart designed for a large man into a small person. There are also, independent of body size, personal variations in individual sensitivity to various drugs. Thus the demand for speed of action generally runs counter to the demand for safety.

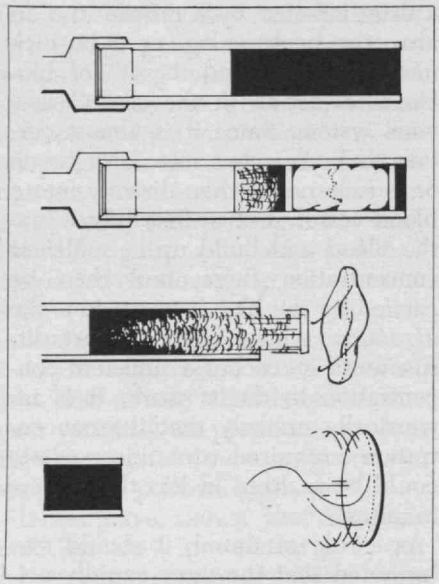
Alternative ways of dealing with this problem are at least conceptually possible. For example, drugs might be found which act at the site of injection. Drugs which induce intense transient local pain are known, but have never been evaluated for their potential effectiveness and safety in stopping a frightened or angry man. Another approach would combine a potent rapidly-acting drug with its antidote. As the concentration of the drug built up beyond the effective level the consequent risk would be simultaneously reduced by the antidote.

As to current practise: for several years the Palmer Chemical Company in Douglasville, Georgia, has been exploring possible use of injector darts in police operations. That company manufactures the Cap-Chur gun, which fires a hypodermic syringe, a weapon widely used throughout the world for catching wild animals (where, of course, one is prepared to accept a fairly high death rate). Experiments by Dr. William Conner at Emory University, Georgia, showed that using this equipment one could relatively safely inject a vomit-inducing agent that was effective in some 3-5 minutes. It may very well be that an acting time of several minutes is not unreasonable. It would basically depend on how long a police officer can keep his target in view.

Another approach to the injector concept is being pursued by Rodana Research Corporation, Bethesda, Maryland, who developed the Atro-Pen, an automatic self-injecting syringe for administering the antidote to nerve gas. A trooper exposed to nerve gas would have to act reliably, quickly, and unhesitatingly to inject himself with the antidote if he is to obtain its maximum benefit. The AtroPen, when put in the active position, need only be vigorously pushed against the leg or any other body surface. The needle is automatically thrust forward and the syringe empties 0.7 millilitres of liquid into the target in 0.3 seconds.

Preliminary attempts have been made to adapt this device to flight by fin stabilization, but these experiments have so far not proven satisfactory. On a trial basis, three Atro-Pens have also been built into a nightstick.

In summary, the development of a tranquilizing gun or tranquilizing



The "stun-bag" principle is termed by its manufacturer a "major technological breakthrough" in less-lethal firearms. The gun is loaded with a "stun-bag," and the rifled barrel imparts spin to the projectile, which under centrifugal force opens to its full diameter upon emerging from the muzzle. The projectile then flies flat to its target. (Photos: MB Associates)

dart presents far more serious biomedical, mechanical and tactical problems than does the development of a topically effective tear-gas agent. One may anticipate that it will require a substantial budget for research to develop an effective, safe, reliable injector weapon. If available, however, such a device could fill a large gap in the police armamentarium. There is now no device (conventional or otherwise) shown to be safe which may be used against a fleeing individual. A non-lethal device effective at a distance would also be useful in dealing with psychotics, would-be suicides and in a number of other special police situations. It might also be useful to private guards, and in the civilian population for home protection.

Modified Fire Arms

The gun is so familiar to U.S. police as a weapon that it is natural that many attempts have been made to modify it for non-lethal use. A dual-function sidearm with both lethal and non-lethal capabilities has been sought in a variety of ways. In general these approaches face substantial technical difficulties and are not likely to be operationally acceptable. Dual function almost necessarily implies that one would have to permit a margin of failure—if the switch in function depends on a button, one must expect the button to be flipped the wrong way some percentage of the time, particularly in the fears and stresses of conflict.

The other approach is to modify the bullet in one way or another—generally to go to plastic, rubber, or some other non-penetrating material. These attempts to achieve a stunning or concussive effect are not likely to be successful because of the

Impact projectiles include the Hong Kong pellet gun, the flying bean bag, the nutcracker, the blob projector, the Stun Gun, the net-casting gun . . . Most such weapons are civilian by-products of military research; the lack of research commitments by domestic police prevent alternative approaches to benign incapacitation.

small margin of safety between a high velocity, small cross-section impact which would knock one off balance or stun, and the infliction of permanent or deadly injury.

The shotgun is commonly used in the U.S. in police operations, both in riot control and on a standby basis for special situations. A variety of special shot and shells are available for it, including one which fires rock salt (to disperse a mob). Tear-gas projectiles have already been mentioned.

Though there is much economic, technical and administrative good sense to a single special weapon with a variety of deadly and non-lethal functions, such a weapon may not be desirable for use by the individual policeman in his day-to-day encounters. It may confuse him, the victim and the bystanders.

Impact Projectiles

Several innovations already in use or on the drawing board use mechanical impact projectiles substantially larger than those which are fired from conventional firearms. One of these is the Hong Kong pellet gun. It fires short fluted cylinders of wood. These travel at a high enough velocity to whistle but slow enough to be seen, and administers a smart blow. They are used by the Hong Kong riot control forces with reportedly great success. The whistling and visibility give "early warning" which has the desired effect of dispersing the mob. The physical impact is of secondary importance. The psychological impact is primary. A modified version of this has been used in Belfast, Ireland, firing six-inch "rubber bullets" from the same pistol used for C.S. cartridges. They are aimed at the crowd's legs, or at the ground to ricochet into the crowd. Those familiar with the use of the rubber billets report them to be quite successful and relatively harmless, but we know of no systematic evaluation of their safety or effectiveness. The risks intrinsic in firing a relatively high-velocity, relatively hard missile make it unattractive in view of the ready availability of an established benign alternative, tear gas.

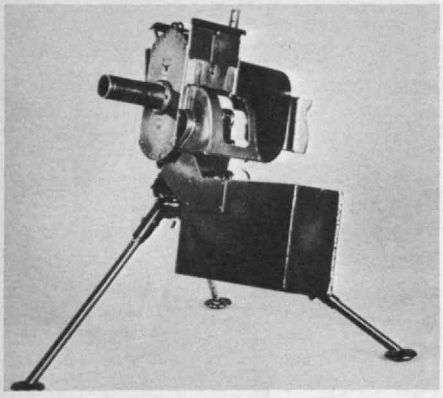
A new device of some interest is the flying bean bag or Stun Gun, developed by M.B. Associates, San Ramon, California. This consists of a soft canvas pouch partially filled with buckshot. It weighs eight ounces and is packed into a cartridge that may be fired from a standard grenade launcher. It is spin-stabilized in flight, and leaves the launcher at 150 feet per second. The non-lethality of the weapon is alleged to depend on the broad, soft cross-section (12 sq. inches) which it presents on impact. Penetration of the skin is unlikely, and the diffuse blow makes permanent injury less likely than with a smaller or harder missile. This weapon has a great deal of superficial appeal, and is already under field trial by at least one police department in the United States. *Nonlethal Weapons for Law Enforcement: Research Needs and Priorities,* a recent report by the Security Planning Corporation of Washington, D.C., to the National Science Foundation, points out that force of impact from the Stun Gun "if fired within 20 feet, . . . may cause death or serious injury to skull, liver, or other parts of the body." Being a cartridge it can be used in a number of ways—for example, in the handle of a nightstick.

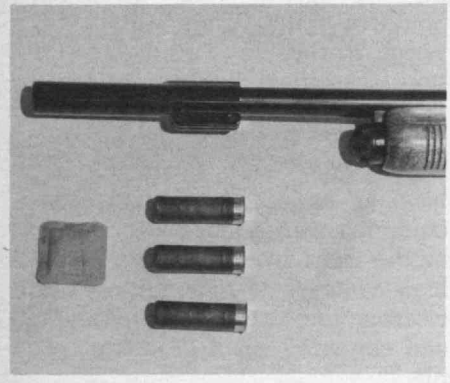
The flying bean bag again underlines the inadequacy of police research and development, test and evaluation facilities in the United States. It may be many years before this weapon, or this class of weapons, is adequately researched and assessed. Should it prove to be safe and reliable it would be quite useful in selected situations in crowd control and may even be of value in the apprehension of fleeing individuals, or (by incorporating a dye) in marking fleeing people or vehicles.

Some Questionable Notions

Weapons based on the high-voltage Tesla coil have largely passed from the public scene as a result of extremely adverse publicity in the mid-1960's following their unexpected and apparently indiscriminate use against blacks in several Southern states. They still enjoy a select market in custodial institutions. Electrical devices specifically designed for riot control have been developed, but are of uncertain value. The West German police have an armored personnel carrier equipped with a gate-like prosthesis in the front which is charged to a high voltage. It may be used for clearing the street or rounding up and cornering small groups of people.

A U.S. patent was granted in 1965 for a device which projects an electrically charged stream—in fact two streams, one positively and one negatively charged, which would meet at the target to close the circuit. A recent innovation is an electrified police jacket which jolts anyone who touches it. This may be useful and acceptable, being a self-administering weapon, if one presumes simply that it is always unlawful to touch a police officer. Whether this device is in fact useful and sufficiently rugged to justify its cost is an open question.





The "stun-bag" principle can be used with conventional weapons as well as special ones. The top and middle illustrations show the basic "stun-gun" fitted with a special stock and the "stun burst" automatic less-lethal riot control weapon; the bottom photograph shows accessories available to convert a 12-gauge single-barrel shotgun to fire less-lethal projectiles. (Photos: MB Associates)

The study mentioned above concluded that "chemical and electrical weapons offered the greatest promise in the short term . . ." That enthusiasm for electrical weapons may be influenced by the Taser, a new weapon which fires small barbed electrical contactors which snag the victim's clothing. The electrical charge administered through the barbs paralyzes the victim until the contacts are removed or the current shut off. While it has been insufficiently tested and researched for effects, the manufacturer claims that it operates in a safe regime, even across the chest.

A number of devices have been offered in recent years which seem to have little to recommend them other than that they may be effectively injurious weapons. One of these is a device called the nutcracker. It consists of two one-foot-long plastic sticks joined by four short nylon cords. Applied to the arm of the offender, much like a nutcracker, it is alleged to produce a severe and immobilizing pain but no physical injury. The application in mob control would find the policeman holding one end of it and swinging the other end as a flail. It is claimed that a blow with this can crack a skull. That, of course, is just what is to be avoided.

A mace-like device has been invented by a Toledo policeman which consists of a steel rod with a length of heavy chain at one end; it is recommended that it be swung like a golf club at the ankles of people in unruly crowds. Both of these devices, however effective they may be, carry such a risk of physical injury, and a more serious risk of conscious or inadvertent abuse, that rather than being a step forward in developing non-lethal weapons they are a step backward into institutionalizing the potential for brutality.

Within the last six years a number of concepts have been proposed and devices developed for which no market has been found. Among these are a foam generating machine that turns out prodigious quantities of foam in a matter of minutes; and a slicking agent which when spread on the ground and moistened reduces friction enough to make walking impossible, or at least extremely slow and tedious going. Another concept is the blob projector—a device which will project a blob of material, which on impact might release a tear agent or a marker. A gas gun of this sort is currently sold for marking trees and cattle for culling. It has not been systematically explored for police application. A net-casting gun has been developed, but this again failed to find a ready market.

Toward Benign Attention?

Many of the easy gains that have been made in the development of non-lethal weapons have been based on the topical effects of tear agents. The basic agents and the innovations in their mode of delivery have come about, and found extensive use in the last few years, chiefly as a result of the large and expensive research and development programs of the military services: they are a civilian by-product of military research. Being topical irritants, tear agents present (as it happens) relatively limited intrinsic risk to humans.

The lack of adequate research commitments to any aspect of the employment of weapons by domestic police will certainly hold back the development of alternative approaches to benign incapacitation, involving for example mechanical impact, injected drugs, or electrical devices. These approaches to weaponry involve physical and physiological effects which are more complex, more subtle, and intrinsically more risky than the application of topical irritants.

Added to this is a surprising reluctance on the part of the police to assume the burden of training and discipline required for effective implementation of any new weapon system. A survey by the International Association of Chiefs of Police on chemical projectors showed that some 23 per cent of U.S. police forces provide no training in the use of these weapons.

Unfortunately it still seems to be the case that the dominant tendency is to substitute brawn for brains, grossness for finesse, and force for skill. Against this there is the hope that now that the conventional police armamentaria are full, the confidence inspired by feeling "able to deal with anything" may encourage a new wave of technical development—perhaps toward the benign, evenhanded, skillful application of force, only to the extent allowed by law, and governed by prudence and humane concern.

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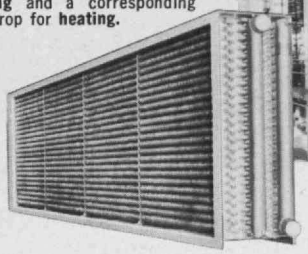

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Trend of Affairs

Trends This Month

ENERGY

Reactor safety: more on the loss-of-coolant problem . . . "Irrelevant" statistics on the forces of nature . . . A new look at hydrogen as the fuel of the future

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Moving technological innovation from the ivy-covered walls . . . But has the spirit of innovation already perished?

TRANSPORTATION

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ENERGY

A.E.C. Suffers Loss of Cool

The Atomic Energy Commission's public "rule-making" hearings on emergency core-cooling systems, which began in January, seem likely to continue until around July. The central issue is whether U.S. water-cooled power reactors, existing or currently designed, will remain safe in the event of a loss of the coolant that surrounds the core. All such plants possess systems intended to provide an emergency coolant supply for this contingency, and thus prevent the fuel elements from overheating, breaking up and melting. The question is whether these systems can be expected to work.

In physical and engineering terms, the use of an emergency core-cooling system following a loss-of-coolant accident is an extremely complex event in an extremely complex system. Designers are required by the Atomic Energy Commission to ensure that, during such an event, certain specified criteria (of, for example, temperature) will be met. To check on whether the design meets the criteria, computer simulations are employed.

The practical bases both for the criteria and for the computer routines are now being regarded as questionable (see *Technology Review*, Oct./Nov. 1971, pp. 77-78). Last year some experimental results were reported which cast doubt on the ability of at least some of the manufacturers' computer programs to give a useful quantitative description of the workings of an emergency core-cooling system (E.C.C.S.). The Atomic Energy Commission rather quickly issued a modified, "interim" set of criteria, without publishing the technical justification for them which was at first promised. And a group of independent critics, identified with the Union of Concerned Scientists (U.C.S.) and including Henry W. Kendall (Professor of Physics at M.I.T.), began to conduct their own examination of E.C.C.S. theory and practise.

In this year's hearings the U.C.S. team features as the spearhead of a coalition of 52 environmental and citizen groups, known as the National Intervenors. Their main spokesman is Myron Cherry, a lawyer associated with the Chicago-based "Businessmen for the Public Interest." Early in the hearings, they demanded the public release of 61 internal A.E.C. documents: mostly memoranda by A.E.C. regulatory staff members, addressed to one another or to the group which produced the June '71 interim criteria. The hearing board at first refused, but the A.E.C. commissioners chose to release all but four.

The documents reveal what *Nucleonics Week* termed, in a special report on them (Feb. 17, pp. 7-14), "a strong measure of staff concern that

☐ "the interim criteria on E.C.C.S. are not conservative enough;

☐ "accident-condition factors such as coolant-channel blockage are not sufficiently understood or allowed for;

☐ "experimental tests conducted so far have little or no relevance to the large reactors now being built;

☐ "computer codes used for calculating the results of a hypothetical loss-of-coolant accident are relatively crude, lack much needed data, involve too much 'patching' between one code and another, were intended for 1965 and 1967 reactor designs, and should be replaced by much more sophisticated codes as soon as possible."

The point about "factors such as coolant-channel blockage" is that, in the absence of coolant, fuel elements will heat up above their design temperature, and might conceivably swell and distort sufficiently to prevent the entry of the emergency coolant, when it arrives, into at least some of the core; in which case heating and disruption would continue uncontrolled. The design criteria are intended to specify a system which will act fast enough to prevent this from happening, and a major point at issue is whether they really do.

The last of the four "staff concerns" is well expressed in a passage in the Water Reactor Safety Program Augmentation Plan produced by Milton Shaw, director of A.E.C.'s Division of Reactor Safety and Development, in November: "To date, the evolution of codes has not kept pace with the development of E.C.C. systems. As reactor designs and their operating characteristics changed, the analysis methods were 'patched up,' rather than redeveloped, with the net result that, overall, existing methods are inefficient, inflexible, and do not adequately represent the physical phenomena intended."

The root of the trouble may have been identified in a letter from C. P. Siess, Chairman of the A.E.C.'s Advisory Committee on Reactor Safeguards to the Chairman of the A.E.C., James R. Schlesinger, this February: ". . . the Committee finds that the relative roles and responsibilities of the utilities, the reactor vendors, and the A.E.C. with regard to safety research have not been clearly defined. Further, . . . there has not yet been formulated a sufficiently specific definition of the national safety research needs for water reactors, including the means and schedules to be used in resolving problems."

It has sometimes been argued that a loss-of-coolant accident is calculated to be extraordinarily unlikely, requiring a kind of structural or plumbing failure which is massively guarded against at all points in design, construction and operation—and that therefore a moderate reliability in the E.C.C.S. is quite acceptable. The U.C.S., in a weighty "Evaluation of Nuclear Reactor Safety" published this March as testimony to the hearings, appends a selection of accounts of mishaps from the A.E.C.'s *Reactor Operating Experiences*. Particularly, attention is drawn to a chaotic chain of events which occurred at the Dresden II reactor in June 1970, involving loss of control of water level; the group remarks :"The *a priori* probability of the kind and sequence of events of this accident occurring at all, computed by conventional estimation procedure, is so small as to be utterly negligible by any standard." And yet it happened. Performance may well fall far short of the probability predictions. —*F.W.*

120 Million Mw. For Nothing

Industrial man has learned to do a variety of things for himself, but there are still a number of vitally important things that nature does for him, free of charge. A fairly well known example is the pollination of farm crops. Another is the lifting of water to a height of the order of two miles, preparatory to dropping it as rain.

Carnegie-Mellon's Professor Richard A. Rice (author of "System Energy and Future Transportation" in *Technology Review* for January, 1972, pp. 31-37) calculates that rainfall onto the planet's land areas involves a steady expenditure of 160 billion h.p., simply on the basis of work done against gravity (and leaving aside the heat used in evaporation, and the work done in transporting the water from oceanic to continental regions).

The world's total annual oil production, Professor Rice concludes, "would 'operate' the world's rainfall system for . . . about 35 hours." The U.S. annual oil consumption would power the nation's rainfall for some 17 days. It would, alternatively, drive the Amazon River ("possibly the most impressive natural land-based transport system") for 12 days, using the most efficient technology known.

These "relatively irrelevant statistics" are from a paper presented to a conference of the Canadian Institute for Guided Transport in Kingston, Ontario, in February. Elsewhere in the paper Professor Rice costed out the creation and operation of a completely man-made, competently landscaped 10-mile trout stream. He arrived at a capital investment of $245 million, without the "animals, birds and fish which we hope will be gifts," and an annual operating cost of $17 million ("before depreciation and capital charges").

Having thus established his reverence for nature, Professor Rice proposed a transportation system—for people, not water or trout—featuring an artificial wind. He envisaged a 20-ft.-wide cycleway, the capacity of which would be 300 cyclists per mile. Travelling at 20 m.p.h., each cyclist would ordinarily expend half a horse-power, but if the cycleway were enclosed and 50-h.p. electric blowers were installed at one-mile intervals to provide a following breeze of the same speed, each cyclist would need to deliver only ⅛ h.p. Thus, "installing 50 h.p. relieves the cyclists of up to 112 h.p. of wind resistance" (because the walls of the cycleway are less obstructive to airflow than are the cyclists). More realistically, a 20 m.p.h. following wind would probably take 100 h.p. per mile, but this still gives 500 to 700 passenger-miles per gallon-equivalent.

"Urban passenger movement at up to 20 mile/h. block speed is available for perhaps one-third the investment, one-tenth or less the power, and possibly one-fifth the annual operating commitment of other high-density people-movers," said Professor Rice.—*F.W.*

A Hydrogen Era?

An aerospace technologist from N.A.S.A.'s Langley Research Center; the head of the Materials Division of Euratom's I.S.P.R.A., Italy; an engineering professor from the University of Oklahoma; and a research administrator from the Institute of Gas Technology: all were in complete agreement when they came together at the April meeting of the American Chemical Society. The fuel of the future would be hydrogen, for nearly all purposes except the running of central power stations, where the hydrogen would be manufactured from water.

At first sight it might seem rather

pointless, from an energy-conservation standpoint, to burn hydrogen (to water) at one place while extracting it from water at another. But Dr. D. P. Gregory (of the Institute of Gas Technology) was not alone in suggesting that if we view hydrogen as a medium of storage and transmission for energy, as compared with electricity, the gas wins—not only on storage, but on efficiency in transmission. Besides, underground pipelines are out of sight and out of mind, unlike electric power lines.

The Institute of Gas Technology, faced with a diminishing supply of natural gas, is evidently seeking substitutes. Under the sponsorship of the American Gas Association, the I.G.T. is studying the possibility of a future "hydrogen economy," in preparation for the day when, as Dr. Gregory said, "the cost of natural gas will exceed that for hydrogen."

Roger J. Schoeppel, of Oklahoma State University, leads a group which has patented a new type of hydrogen-fueled internal-combustion engine for cars. Previous hydrogen-burning cars, he said, have been plagued by pre-ignition and other even more alarming problems. This applied to the German systems of the 1930's and—he thought—to the five hydrogen cars now being prepared for this year's student Urban Vehicle Design Competition. In his system "the hydrogen is ignited immediately upon the start of injection and burns as a 'jet' during the short period of its injection—thereby eliminating all prospects for pre-ignition and detonation." The fuel-tank would probably consist of a steel vessel containing about 500 lb. of finely divided magnesium, which forms a hydride that decomposes a little above ambient temperature.

(Incidentally, metal hydride chemistry should enjoy something of a revival in connection with the design of fusion power plants. Not only are reactions between structural metals and hydrogen isotopes of vital importance in any conceivable fusion-power system, but tritium—hydrogen-3, a fusion fuel—must somehow be stored after extraction from the lithium in which it is created, to await insertion into the core. It became evident at the American Chemical Society meeting that, although the properties of many hydrides are well known, the variations which occur when the hydrogen is in the form of deuterium or tritium are not.)

Dr. Schoeppel is determined not to construct an unreliable lash-up such as might reinforce the public in their suspicions of hydrogen (a form of skepticism which the four hydrogen enthusiasts agreed in calling the Hindenburg syndrome). A thoroughly engineered hydrogen car would cost more than he has so far been able to obtain; but the Environmental Protection Agency is beginning to sound somewhat more sympathetic than it has in the past.

From the National Aeronautics and Space Agency came a proposal for a liquid-hydrogen fueled long-range airliner flying at Mach 6-8. This idea was closely related to a more general proposal for a hypersonic research aircraft, with the difference that—according to the speaker, Robert D. Witcofsky—if such an aircraft carried liquid hydrogen it could be constructed of aluminum, instead of the expensive super-alloys usually thought necessary to withstand the high skin-temperatures. The aluminum would be cooled by a second fluid, itself cooled by the liquid hydrogen. Mr. Witcofsky had a little trouble presenting a case for a hypersonic transport, but thought that the demise of the S.S.T. had had something to do with its lmited range, a shortcoming from which his vehicle would not suffer.

How to make the hydrogen? Not by electrolysis, according to Mr. C. Marchetti of I.S.P.R.A., but by a chemical process patented by his colleague G. De Beni in 1970. At 730°C.—calcium bromide and steam convert to calcium hydroxide and hydrobromic acid; mercury is then used to extract the hydrogen from the acid, and in two more easy steps the starting materials are recovered. Mr. Marchetti claims that a pilot hydrogen plant could be running in two years, and points out that 730°C. is within the temperature range of a high-temperature gas-cooled fission reactor.

"But politics is a far more complicated sphere than technology," Mr. Marchetti concluded in a recent survey covering all of the ideas mentioned above, and more (*Euro Spectra*, 1971, No. 4), "and such a simple, logical state of affairs as the one we have outlined must be regarded realistically as a target for the next fifty years."—*F. W.*

LIFE SCIENCES

There Was Peace 40,000 Years Ago

A man placed a bit of shell on a bed of moss some 40,000 years ago and bent to drill a pointed stick into it. In making an amulet, he found fire, according to Louis S. B. Leakey; it was about then that man became a social creature, with feelings that he at least felt or recognized towards other men—friendship, hate, jealousy.

The earliest skeletons are found singly or in small family groups, Dr. Leakey (who is a director of the National Museum in Nairobi) told the American Association for the Advancement of Science last December. Only about 40,000 years ago did man come to live in larger groups; he became "psychosocial man." He decorated his body with amulets and red ochre; he began to use tools. And when he found fire, he had leisure as well, for fire defended him from animals and kept him warm.

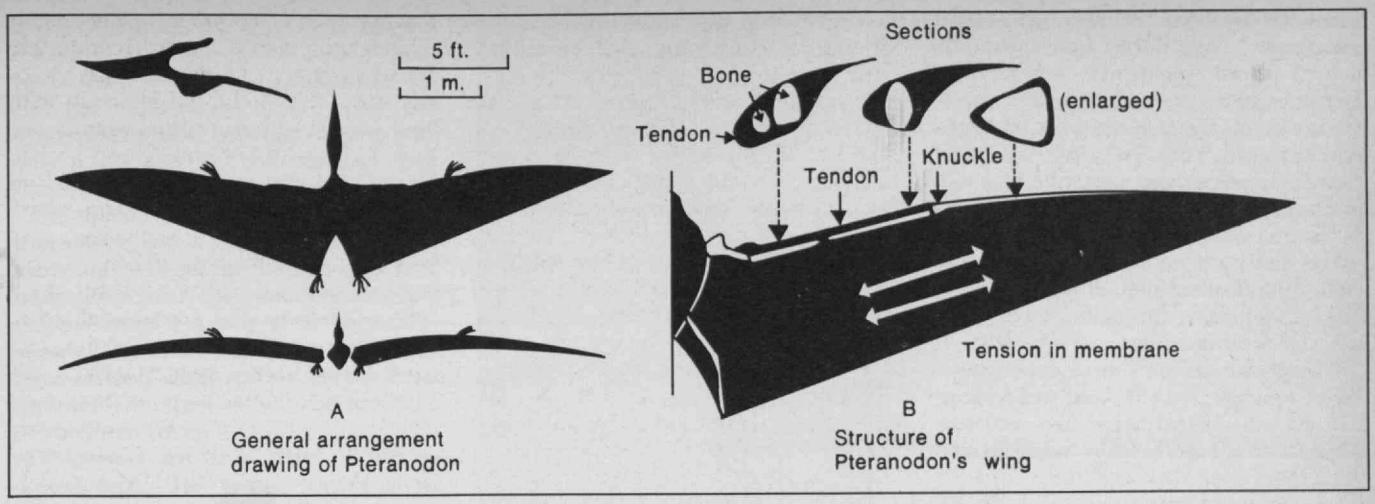
But fire—and a slightly civilized man—demanded shelter. Then began competition, for caves and for food from near them. Before these changes, Dr. Leakey said, man had no need of being destructive—and was not. We have since become the most dangerous of all animals. But, he added, the situation is not hopeless. Perhaps we are again now in a period of change.

Other Species in Odd Predicaments

Two other speakers at the same session, on the biological basis of destructive behavior, talked about the behavior of other animals: monkeys, it seems, become destructive if they are raised with too few other monkeys, and mice become destructive if they are raised with too many other mice.

Halsey Marsden reported work from the National Institute of Mental Health (with John B. Calhoun and Lorenz K. Y. Ng) in which mice were placed in a world limited in space. Given enough food and water, the mice multiplied until all sorts of aberrant behaviors precluded the bearing of more young. The mice miscarried or did not mate at all, territorial defensive and nest-building actions nearly disappeared, and most of the mice became withdrawn and sporadically aggressive. Selecting the most normal and most abnormal, Dr. Marsden found that the abnormals had a much higher level of the hormones involved in stress responses—dopamine and epinephrine, for example—than the more active "normals." He suggested that the withdrawn mice were being passive so as to reduce the levels of these hormones.

Allyn Deets of the University of Pittsburgh and Harry Harlow of the University of Wisconsin tried isolating newborn monkeys for varying periods of time—some for life—and observed their expressions of fear and aggression as they faced a threatening stimulus. Dr. Deets reported that a newborn has no capacity for fear, but fear begins to develop in a healthy baby monkey by about three months. A monkey isolated for longer than that suffers irreparable damage in his social relationships, and the longer he is separated from his fellows, the more aberrant and vicious are his destructive expressions. In those animals "condemned for life" to isolation, Dr. Deets said, the aggression is turned against themselves: they "viciously bit and tore their own flesh. . . . One adult



The world's largest bird, the Pteranodon, is here drawn as two English researchers—an engineer and a palaeontologist—imagine it, after stress analysis of the possibilities. The bones of the wing even have cross-sections highly adapted to the stresses they must meet: though thin, their walls concentrate the weight on the corners where it must be strongest. (Drawing: *New Scientist*)

isolate even managed to partially blind himself."

Dr. Deets began his report by claiming that the study of aggression in primates could illuminate man's "biological heritage as a primate," since aggression is "indigenous to the nonhuman primate" and "most likely" remains also a part of man.

Dr. Leakey had only one response: I object to those psychologists who try to extrapolate on slender evidence from animals to man, he said.—*J.K.*

Getting to Know The Pteranodon

Faced with a mess of prehistoric bones, paleontologists arrange and surmise, but they rarely analyze the imagined skeletal forms to discover whether they would really work. By doing so, last year Robert Bakker of Yale University deduced that the brontosaur was actually a land, rather than a water, animal, one rather like an elephant (*see* Technology Review *for June, 1971, p. 64*). Two scientists at the University of Reading, England, have now given us a new view of the life of the world's largest flying animal, *Pteranodon ingens*, a pterodactyl from the Cretaceous period.

"In flying animals," Dr. George Whitfield and Cherrie Bramwell write (*in* New Scientist, *Dec. 23, 1971, p. 202-5*), "engineering requirements are particularly stringent; the conflicting demands of aerodynamic shape, weight saving, and structural strength show clearly in the animal's design."

Pteranodon, they think, weighed only 35 lbs. and had a wingspread of 23 ft. Its wing, they write, was like "the sail of a Bermuda-rigged boat": a leading-edge spar formed of very long, slender bones—the wall of the bone was only 1 mm. thick—carried a thin, flexible membrane. "The membrane has to be stretched to resist the air loads, but none the less bellies upwards. To avoid twist in the wing which would reduce the performance, the leading-edge spar has to curve downwards towards the tip, following the curve of the membrane," they write. And Pteranodon's wings do so curve. The wing spar is also built and supported so as to resist stresses that push it upwards and backwards: "A strong tendon runs along the front edge of the wing" (from a knuckle joint midway to the shoulder). "When taut this tendon holds the wing extended and provides much of the strength of the inner part of the wing spar." At the knuckle the tendon is in front of the bone, to resist a backward force. Closer to the shoulder it lies below the bone to resist the upward force.

Pteranodon had a crest extending back from its head, that gave him a claw-hammer appearance. Models were tested in a wind tunnel, and the crest turned out to be an aerodynamic device to balance the drag on the beak when the head was turned during flight, thus reducing the strength needed in the neck muscles.

On the ground, Pteranodon would have been able to stand on his feet and fingertips but his joints would not have made walking easy. Nor were his wings capable of powered flight, the authors suggest: "Clearly Pteranodon was a very efficient glider with an extremely low rate of sink, and a very low flying speed. This is the key to understanding his way of life. He lived at sea, soaring in the rising air where the wind blows over waves, and eating fish. He nested on cliffs facing the prevailing wind. . . . Thus Pteranodon was adapted for light reliable winds, and his ecological needs fit in with the warm shallow seas and pleasant climate of the Cretaceous."—*J.K.*

Man or Mouse?

Professor Howard Green of M.I.T.'s Department of Biology is growing hybrid cells created by the fusion of human cells with those of the mouse. These hybrid cells allow research on human genetics that has been impossible previously, for in effect they provide a medium for growing and observing single human chromosomes.

Cell hybridization, first observed by French researchers Georges Barski and Boris Ephrussi in cell cultures of two mouse strains in 1960, occurs infrequently even in ideal laboratory conditions—perhaps one cell out of 100,000. Only after a variety of cells were successfully hybridized—including rat-mouse and mouse-hamster—did Professor Green and Mary C. Weiss, both then at New York University, finally achieved the hybridization of man-mouse cells in 1967.

Through a process not yet understood, the human chromosomes in a hybrid cell are selectively eliminated as the cell reproduces. Professor Green's research takes advantage of this rejection of human chromosomes to determine which chromosome is the site of a specific gene.

"This type of analysis may possibly be made the basis of a general method for the chromosomal assignment of human genes," Professor Green notes in an unpublished report summarizing his research project. "We are studying other selective systems based on drug resistance with a view to preparing a larger battery of reduced human-mouse hybrids each containing a single human chromosome."

Professor Green is also using the minuscule laboratories provided by hybrid cells to determine which chromosomes allow viruses to attack mammalian cells. Human cells, for example, are susceptible to infection by polio virus because of the existence of a human gene that directs the synthesis of polio receptors which allow the virus to attach itself to the surface of the cell. In tissue culture all primate cells are susceptible to polio virus; but species of other orders are resistant.

In Professor Green's virus experiment, human-mouse hybrid cell lines sensitive to polio virus were first isolated. Then such a line of cells was infected with the virus. Most cells thus infected were destroyed, but a few survived and were found to be permanently resistant to the virus. These cells had evidently lost the human chromosome bearing the receptor gene. If that is the case, then comparing the chromosomes in virus-sensitive and virus-resistant cell lines should turn up the chromosome bearing the polio gene. Thus Professor Green suggests that hybrid cells may tell us about the genetic basis for the sensitivity of cells to viral infection.—*Peter Spackman*

PHYSICAL SCIENCES

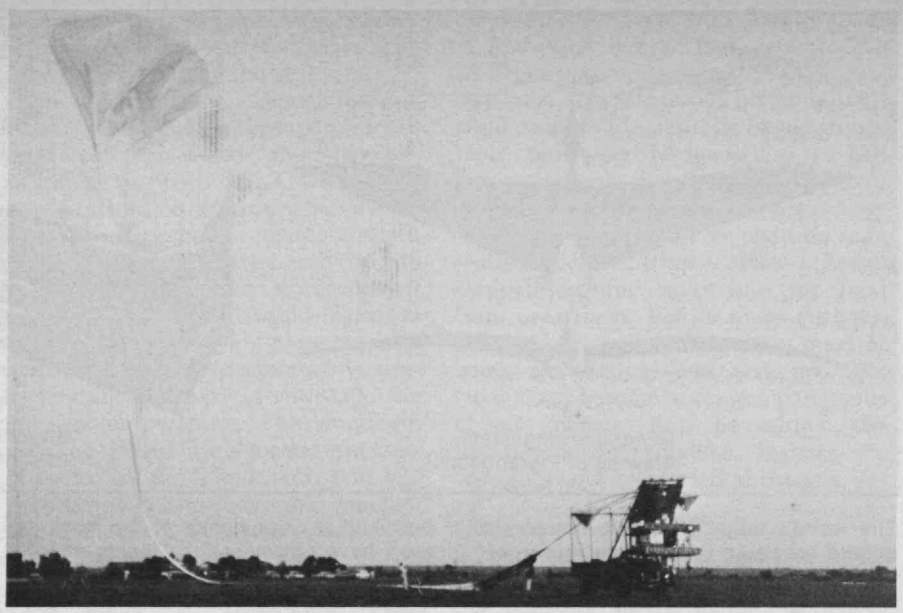
Up and Away

The largest balloon ever flown ascended successfully last April 5 from the central plains of Australia. Its 46 million cubic feet of helium, contained within acres of half-mil polyethylene, made a one-way trip to the top of the atmosphere. The fragile giant's mission was to carry to a height of nearly 150,000 ft. a 1,000-lb. package of equipment for studying the sources of cosmic x-rays.

Professor Walter H. G. Lewin of M.I.T. (the principal investigator) explained that astronomical x-ray detectors need to be above as much of the earth's atmosphere as possible. Atmospheric attenuation of x-rays is such that if the balloon flew just 20,000 feet lower the x-rays observed from one typical source of interest would be down by a factor of 10.

"But in addition to looking for x-rays," Professor Lewin said before the launch, "we are pushing the limits of balloon technology. We don't know for sure whether or not this balloon will perform satisfactorily—I give it about a 50-per cent chance. It may split open, or it may actually pop at altitudes around 40,000 feet where temperatures drop below −40°F."

But the balloon fared well, its payload gathering data for 23 hours until cut loose to parachute back to earth. A second try two weeks later, using a 36 million cubic foot balloon, did fail.



A helium balloon like this one—only larger—carried x-ray telescopes high over the central plains of Australia this spring. M.I.T.'s Professor Walter H. G. Lewin used the balloon in his investigations of cosmic x-rays—and incidentally set a new world's record for largest balloon ever flown.

The search for cosmic x-rays has been conducted with balloons, rockets, and satellites. Most x-ray sources now known emit most of their power in the "soft" x-ray spectrum, with particle energies in the one-to-ten keV. range. Professor Lewin's balloon will look into the "hard" spectrum, where particle energies lie between 15 and 150 keV.

The search for high-energy x-rays is particularly difficult because they are so scarce. Since x-rays are quantized, lower power means the x-rays arrive less frequently, so it takes time to accumulate significant observations—more time than is available when using a rocket probe.

Of the dozen or so hard x-ray sources which have been discovered, only three have been identified as visible objects. One is the Crab Nebula, another is a neutron star within the Crab Nebula, and another is a blue star known as Sco X-1. The mechanism responsible for these cosmic x-ray emissions remains unknown.

Most of the known sources of interest lie in the southern skies. Thus because he wants to observe them through a minimum of atmosphere, Professor Lewin launches his balloons in the southern hemisphere.

When an x-ray photon enters Professor Lewin's instrument at the proper angle, it strikes a crystal which then scintillates—that is, converts the x-ray energy into a burst of light. The light is registered by photomultipliers. The stronger the light, the higher the energy of the x-ray; the more frequent the bursts of light, the higher the flux of x-rays.—*R. A.*

Probing for Lunar Conductivity

As the astronauts have discovered, probing the interior of the moon is quite a difficult task—at least when using a mechanical core sampler. The crew of Apollo 17, scheduled to fly at the end of this year, will try a less strenuous, though possibly more powerful method.

M.I.T.'s Professor Gene Simmons and his colleagues have developed a sensitive electromagnetic probe which will explore the moon's electrical properties down to 10 km. below surface. It is designed to look for layering of the moon, reflecting bodies 10 to 100 meters in size but not seen at the surface, and variation of electrical properties with depth. (*See* Technology Review *for October/November 1971, p. 78.*) It will also detect subsurface water —in the unlikely event that any is there.

Radio waves can penetrate a nonconducting medium like the dry soil of the moon quite freely, at least by comparison with earth. But if there are different layers under the lunar surface with different dielectric constants (a characteristic of different kinds of matter), then part of the power will be passed through the interface between the layers and part will be reflected back up. The effect is almost exactly the same as the partial reflection of light when it passes from air into glass. (In fact, the familiar refractive index of Snell's law is, in the case of nonconducting nonmagnetic media, simply the square root of the dielectric constant.) Re-

turned samples of lunar soil have a dielectric constant of 3.3, while lunar rocks have a dielectric constant of 10. But the radio probe, it is hoped, can even distinguish between layers with only a few per cent difference in their dielectric constants.

The apparatus consists of a stationary transmitter and a mobile receiver. The astronauts will set up the solar-powered transmitter near their landing site and unwind from it a pair of orthogonally-oriented transmitting antennae in the form of long wires resting on the lunar surface. The receiver will be mounted on the lunar rover.

Of interest are three parts of the radiated field: that which travels along just above the surface, that which travels along just under the surface, and that which is reflected back up from underlying discontinuities. The three will produce an interference pattern which will be mapped along the path followed by the rover.

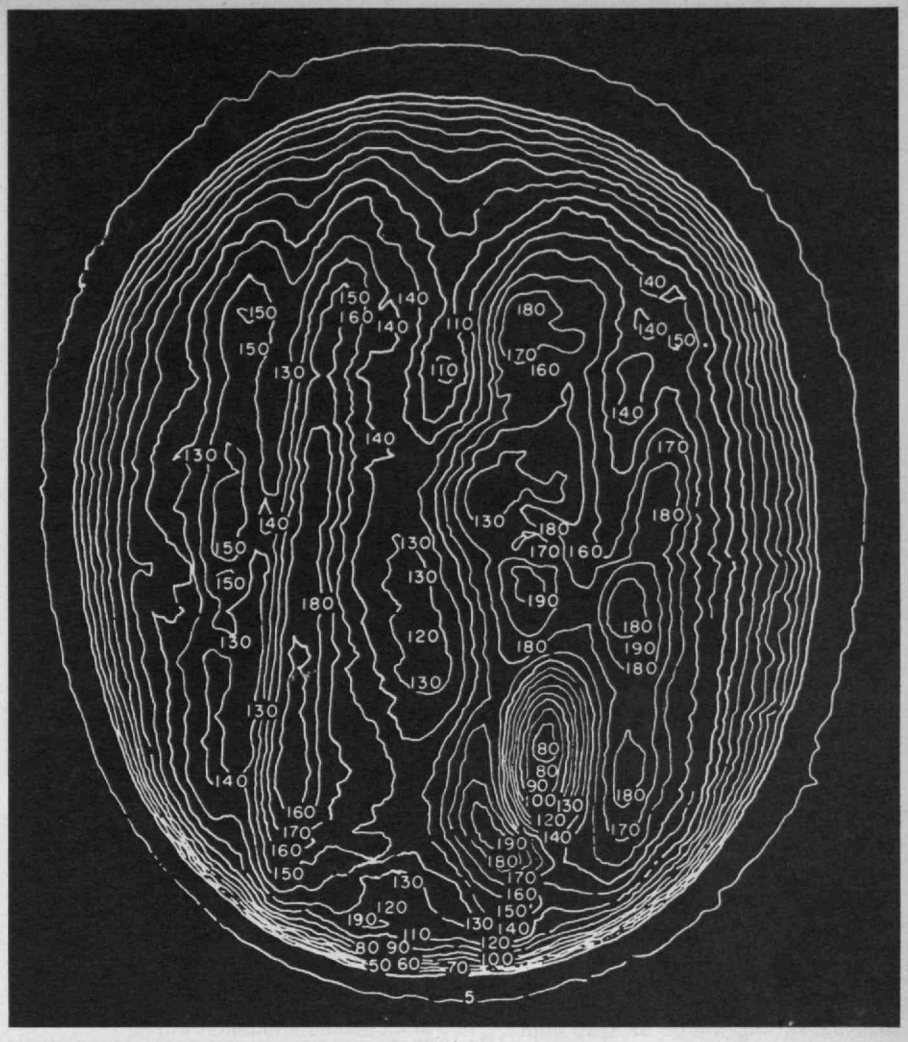
The transmitter will use its two antennae in alternation and will transmit, in sequence, on frequencies of 1.0, 2.1, 4.0, 8.1, 16.0, and 32.1 MHz. The receiver will monitor each transmission through each of three orthogonally-polarized antennae, yielding 36 items of data for each receiver location. Location and heading, given by the rover's navigation system, will be recorded along with the data on a magnetic tape which the astronauts will bring back to earth.

The technique is a very new one, and one which is unsuited for subsurface terrestrial exploration: our soil, because it is wet and therefore electrically conductive, attenuates radio waves before they can penetrate more than a few wavelengths. So how can you try the system before sending it off to the moon? One kind of formation on earth comes close to matching the low conductivity of the moon: a glacier.

Though liquid water is a fairly good conductor, solid water is a rather poor one—and furthermore, it has about the same dielectric constant as does lunar soil. So members of Professor Simmons' team have been visiting glaciers, first to test the concept, then to test engineering models of the flight equipment, and now to "get first-hand experience with new situations" so that they can be better prepared to interpret the data that come back from the moon.

The probe will show what lies under the moon's surface—at least in terms of its electrical properties. But in particular, it will give further insight into the important question of whether there is water in the moon.

"That's a long shot," Professor Simmons cautioned, "but if there is water present beneath the Apollo 17 landing site, then the probability that we will discover it is about .98."—*R.A.*



These are computer print-outs of data supplied by a vidicon photometer used by its inventors, Professors Thomas B. McCord of M.I.T. and James A. Westphal of Caltech, at the Inter-American Observatory at Cerro Tololo, Chile. At the left is a map of the reflectivity to ultraviolet light of the planet Jupiter, demonstrating the narrow bandwidth of the device's filtering capability. At the right are images of the bright stars in the center of the stellar cluster 47 Tuconae, shown with definition impossible in conventional photography; the vidicon produces an electrical signal directly proportional to the number of photons being received—hence its ability to analyze overlapping images.

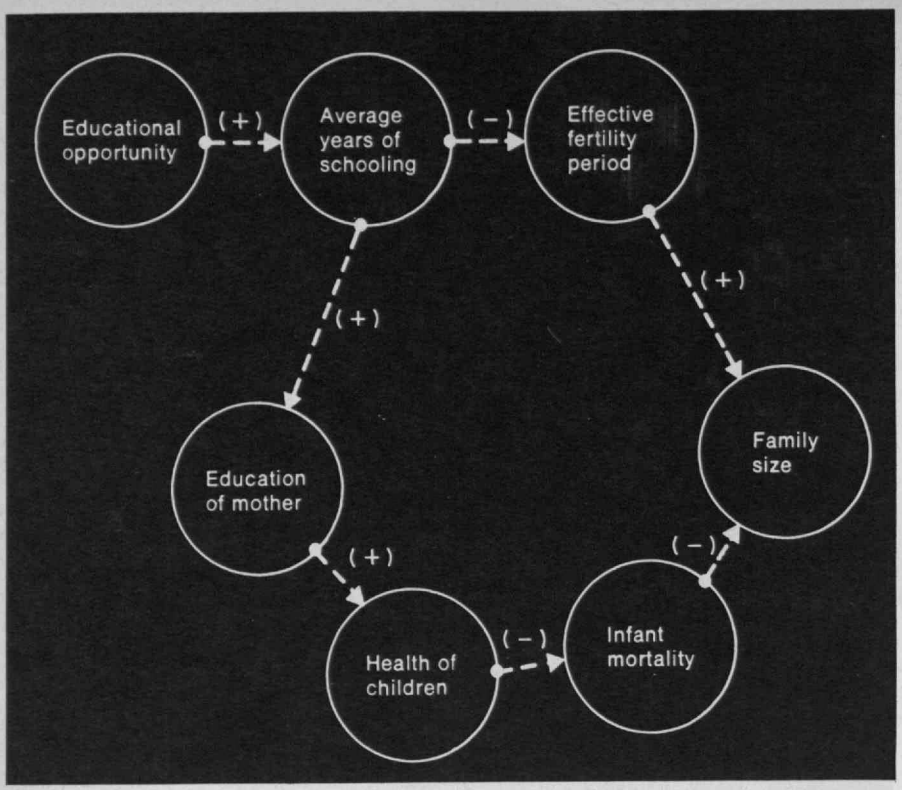
Electronic Telescope

Photographs, the principal means of recording astronomical data for nearly 100 years, may soon yield to a television-like system that makes digital magnetic tape recordings of stellar images through a telescope. The new system is called a "vidicon photometer."

The photometer method, developed by Professor Thomas B. McCord, Associate Professor of Planetary Physics who is Director of M.I.T.'s Wallace Astrophysical Observatory, and James A. Westphal, Associate Professor of Planetary Sciences at the California Institute of Technology, uses a vidicon tube similar to those in television cameras to record stellar images electronically. The electrical signals corresponding to the visual image end up stored on magnetic tape in digital form. The tape is easily delivered to a computer for further processing—which can include construction of two-dimensional maps.

Other devices to replace or supplement astronomical photography have been developed, but this one has three advantages: it is more sensitive, especially at infrared wavelengths; it is more photometrically precise, more nearly registering incoming photons on a one-to-one basis; and it yields data in digital form ready for a computer.

The vidicon photometer has helped its inventors to map the distribution of methane gas on the surface of Jupiter and to distinguish the images of individual stars in dense stellar clusters where photographs show only a single blur of light. It will shortly be used to study the structure of the recently discovered galaxies Maffei I and II—difficult to observe visually because they lie on the far side of the Milky Way.—*J.M.*



What happens to the population of an agricultural village as its level of education is improved? This simplified model, showing both positive and negative influences, begins to suggest to Donella H. Meadows the difficulty of answering that question. If educational level is to be increased, the number of years in school will go up. Family size will thus decrease, for child-raising will be delayed until education is completed. But a better-educated mother will take better care of her children, and infant mortality will decrease. How do these two influences balance? And are the determinants in fact as simple as this? They are not, writes Mrs. Meadows: "These two determinants of family size must be analyzed simultaneously with other determinants to assess what the actual effect of increased education will be."

SOCIETY

A Village Model?

What factors influence birth, death, and migration rates in a farming village?

Anthropologists and sociologists know that the answer is not simple. To better understand it, a research program growing out of the Club of Rome's world modelling project at M.I.T. has been suggested by the system analysis group at the Institute and the Center for Population Studies at Harvard University. The project would take as its starting point the "population" sector of the world model which has been the basis of studies reported in *Limits to Growth*.

But this model is inappropriately complex for an agricultural village, where the key issue is keeping population growth in balance with capital growth—in other words, balancing the number of people against the resources by which they live. The need, writes Donella H. Meadows, is to devise a simple model of "the effects of economic and social factors on population growth and the influence of population growth on economic and social development." It is this two-way cause-and-effect connection which makes the basic question hard to answer.

Mrs. Meadows proposes to develop an agricultural village model from data in a recently completed Harvard study of population trends in north Indian villages—and to test the generality of the model, when completed, with data from villages in Iran and Pakistan. The result, she thinks, could be "a policy or combination of policies (affecting population growth) which works within the present value and decision structure of a village to further the goals of national development programs."

One striking result of Harvard's very wide-ranging and statistically thorough population study (*The Khanna Study*, J. B. Wyon and J. E. Gordon, Harvard University Press, 1971) was that, in areas where the villagers received seemingly adequate training in birth-control methods, birth rates were not observably affected, as compared with areas with no such program. Birth rates appeared to be governed by the choices people made, whether or not Western methods for putting their choices into effect were available. One possibility is that still newer methods might yet make a difference; but another is that the technology is in no way a controlling factor, and that birth-rate trends are in fact governed by influences arising elsewhere in the social system.—*J.M.*

The Predictive Pig

In an isolated region of New Guinea, at roughly twelve-year intervals, the Maring-speaking tribes slaughter their pig population and then provoke warfare with neighboring tribes. This seemingly aggressive and bizarre behavior serves a valuable purpose: it apparently constitutes a judiciously timed, and effective form of population control. Without it, these agrarian tribes would be forced to reduce the fallow period of their farmland, exhausting its nutrient value.

Steven Shantzis and William Behrens of M.I.T.'s Systems Dynamics Laboratory modeled (as part of the "world model" program, under Professor Dennis Meadows) the population-control mechanisms of the Maring tribes, using data from R.A. Rappaport's classic anthropological study *Pigs for the Ancestors*. They found that, with population controlled by war, the tribesmen could farm their limited land indefinitely. The model was also able to show the hypothetical result of, say, a change in the warfare pattern or an increase in the birth rate. It was found that the Maring control system "is easily shattered if pushed past a small range to which it can adapt." Were the Australian government even to dispense smallpox vaccinations, for example, it could prove disastrous.

The heart of the system is the pig population. The pigs are rarely eaten—ostensibly they consume useful food and produce nothing. But they are linked to the human population by a number of practices which result in their being a living analog computer. For example, at the death of any member of the tribe, a pig must be sacrificed. Pigs are a status symbol, and are therefore allowed to multiply—which they do faster than the human population—until their upkeep becomes difficult. This occurs somewhat before the tribe itself runs out of food. At this point a festival is held, featuring a slaughter of the pigs. There follows a period of warfare, in which the tribe loses ten or twenty people. Normal life is then resumed.

The Maring's techniques run counter to some strongly-held Christian values, Meadows points out—in particular, the belief that individual human life must always be saved. But, he adds, "one has to recognize that it is a self-consistent system."—*Michael Chiusano*

Societal Engineering

Engineers like to think of themselves as problem-solvers.

But take away their technological problems and give them society's problems, and engineers are likely to wring their hands in frustration, unable to define terms, measure variables, or collect data. Or else they search in vain for a magic answer out of their repertoire, some new piece of cure-all hardware.

Why? Does something about society's problems make them intractable by engineering methods? Or has engineering education become obsolete in a changing world?

There is a little of both, according to J. Herbert Hollomon, Consultant to the President and Provost of M.I.T.

No one needs be told that today's society is overwhelmingly complex; problems defy engineering solutions because "we do not have a science of complexity." We can't even define and measure the variables, Dr. Hollomon said at an M.I.T. seminar this winter.

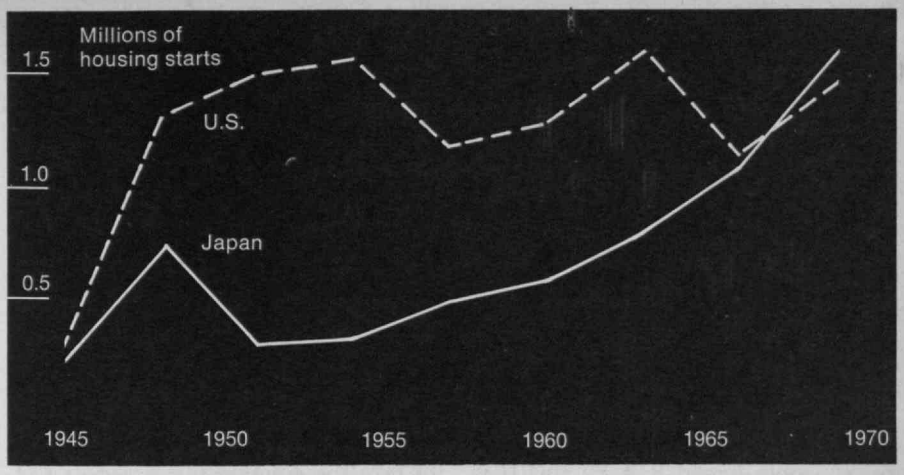
What we need is a "societal engineering" from the practice of which would come "the engineering of total delivery systems—health, education and transportation, to name a few . . ."

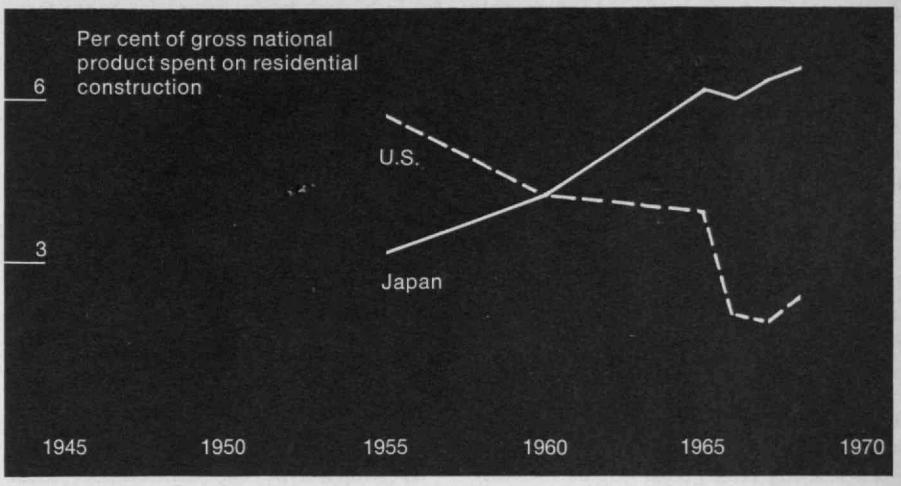
Societal engineering is not systems engineering, because the latter largely neglects the deepest kinds of political, social and psychological interactions. "In health care we keep thinking of more doctors and more medical schools. But perhaps a very large fraction of health care could be self-administered, and providing this kind of option for the polity is societal engineering."

Dr. Hollomon's engineer-of-the-future would have a much better knowledge of non-technical subjects; he would be comfortable with extreme complexity; and the political, social and psychological effects of his designs would be as much a boundary condition to him as the end loading of a bridge is for today's civil engineer.

Does this imply the manipulation of society by "experts"? Dr. Hollomon doesn't think so; the societal engineer would in fact increase freedom by demonstrating alternatives and options. He would, for example, give urban people the same variety of choices and control over their environment that the farmer of 50 years ago enjoyed in a rural society.

No school now offers a degree in this new kind of engineering. The Federal government is now spending more than ever on non-defense, "societal" research and development; the universities' response is overdue, because "the people who are practicioners (in the society) must interact with those who study it."—*Michael Chiusano*





Housing construction has been increasing steadily in Japan since 1951. The result is that Japan now spends more than twice as much of its gross national product for new housing as does the U.S.

Western Living Comes to Japan

If you find the transition in the style of U.S. urban family life disconcertingly rapid since World War II, look at Japan —and take comfort. Japan now spends more on housing than any other nation in the world, but the "sense of tranquility and harmony" that many Westerners have admired in conventional Japanese homes simply cannot be sustained under "the onslaught of industrial production techniques," writes Paul M. Goldberg of M.I.T.'s Sloan School of Management, in a study prepared for the School's Intercultural Communications Program.

Mr. Goldberg emphasizes several characteristics which are together responsible for the near-revolutionary changes in Japanese housing:

☐ Though wages in the Japanese construction industry are low, productivity is even lower; and the Japanese are actively seeking new building methods based in technology to increase construction productivity.

☐ Wood—the traditional building material in Japan—is so scarce that it is, in fact, "essentially an historical building item." Poured concrete is the chief building material.

☐ Western ways of living are gaining ground in Japan. Traditionally, the Japanese used whatever space was most suitable within their largely undivided homes for whatever different needs arose: a single room could serve for entertaining, study, eating, or sleeping. Even today, notes Mr. Goldberg, there is no word in the Japanese language which means "room" in the Western sense. But now every member of the household wants his own space, and so specified functions must be assigned to specified rooms.

☐ Private housing is beyond the reach of most Japanese. The price of an average new house in Japan is six times the average household income; in the U.S., the equivalent of a typical Japanese single-family house may cost $20,000, while the average household income is approaching $10,000. The great expansion of Japanese housing is in apartment units, many in new towns.

The U.S. and Japan today make the same number of housing starts per year, but Japan's population is about half that of the U.S. By 1976, over 60 per cent of all Japanese will live in housing less than 10 years old.—*J.M.*

World Consensus on Environment?

When 120 nations are to agree on how to prevent themselves and their competing neighbors from polluting the global environment, how do they go about it?

The answer: With infinite patience.

Professor William H. Matthews of the M.I.T. Department of Civil Engineering, who is Consultant to the Secretary-General of the United Nations Conference on the Human Environment which opens in Stockholm on June 5, recalls how, two years ago, many people hoped that by this time national governments would be ready to take "formal steps" to begin controlling activities that create international environmental problems.

Things are not moving along quite that fast, Professor Matthews told the National Symposium on the Costs of Water Pollution Control in Raleigh, N.C., this spring. But he is not discouraged.

It's true, of course, that costs of pollution control enter into the economics of international competition; and that the need to pay these costs is seen very differently by developed and underdeveloped countries. But these are not the immediate obstacles.

The documents prepared for the conference reveal "a reluctance to act decisively in the areas of control on the basis of what policymakers now understand about these problems and their implications," Professor Matthews said. Hence the emphasis at the Conference, he said, "will be on assessment—research, monitoring, and informational exchange—and not on international control and regulation."

If there is any single major barrier to progress, it is that governments are in general "not aware of much of the scientific and technical work that has already been successfully completed." It's another example of the extreme difficulty of transferring the results of scientific research from laboratory to policymaker. Perhaps the largest service of the Conference will be to give its delegates a far clearer view of the potential seriousness of environmental problems—and a better understanding of what we now know about them and how our knowledge can be improved.

That understanding will come from documents prepared by the Conference staff to summarize information and viewpoints provided in 12,000 pages of reports submitted by participating nations. Some of the staff effort has been devoted to correlating problems and actions: how many nations see one problem as paramount, how many another? Much more of it has been involved in summarizing information cited in the various contributions, so that delegates to the Conference will acquire a world-wide bibliography. The result is some 800 pages, with copious references through which problems and data can be retraced back to their sources.

The reports of two summer studies of environmental and climatic problems sponsored by M.I.T.—S.C.E.P. and S.M.I.C. (*see* Technology Review *for October/November, 1970, pp. 58-59, May, 1971, pp. 18-27,* and *October/November, 1971, pp. 6-7*)—have been among the significant inputs in this process, Professor Matthews says.

Delegates in Stockholm will be asked to take three actions:

☐ Adopt a Declaration on the Human Environment, incorporating agreed principles of international behavior and responsibilities. This will be a "first attempt to give expression to an international consensus on the environmental ethic," Professor Matthews said.

☐ Agree on an action plan for extended monitoring and research efforts —an Earthwatch to coordinate available environmental data and add new international observation programs.

☐ Recommend new institutional arrangements (presumably a new U.N. agency) to operate Earthwatch and coordinate the U.N.'s environmental concerns.

If adopted by the Conference, these will be brought as recommendations to the United Nations General Assembly next fall. It is here, not in Stockholm, that the political struggle over East German participation could surface to jeopardize General Assembly action on the Conference recommendations.—*J.M.*

Wage-Price Freeze: A New Myth?

"It is at least possible that the New Economic Policy is the first act of a scenario that ends with effective, peacetime direct price controls. . . . Economic myths, once rooted, die hard." Thus concludes James E. Annable, Jr., Assistant Professor of Management at M.I.T., in an article in *Sloan Management Review* (Vol. 13, No. 2, pp. 34-43).

The myth that Dr. Annable fears will become established doctrine is the belief that the wage-price freeze worked —that it fulfilled its intended purpose of curbing inflation. And "once a novel program has been introduced and has been popularly accepted as successful, it is likely to be used again." (The novelty in this case lies in imposing such a freeze in peacetime—or, anyway, in the words of the Chairman of the Council of Economic Advisers, "predominately peacetime.")

The mythological nature of a belief in the present success of the New Economic Policy, Dr. Annable establishes thus: There are two commonly accepted versions of how the inflationary process might begin, termed cost-push and demand-pull. In the former, prices are initially supposed to be driven up by the unions; in the latter, by a rise in the total demand for money in the economy, with the result that "if the economy is already operating at full capacity, the positive excess demand can only bid up the prices of the inelastic supply of output." The New Economic Policy makes sense only in a cost-push situation, says Dr. Annable—whereas the recent inflation was in fact of the demand-pull type, induced by the federal government's having increased its expenditures (from 1965, to finance the Vietnam war) without correspondingly increasing taxation. The record shows that union members, far from taking excessive raises as in the cost-push situation, have been experiencing smaller wage increases than non-members (and thus "providing part of the forced savings used to pay for the war effort").

At the time when the N.E.P. was enacted, writes Dr. Annable, inflation was in any case already beginning to subside, in response to more traditional measures. "It is evident, however, that the slowing of inflation will not be attributed to the discredited old policies but rather to the N.E.P. Thus, another economic myth is born."—*F.W.*

Cult of Technology

The trouble with most statements of engineering need: they are in fact statements of preconceived, possible solutions. And this, says Alfred H. Keil, Dean of Engineering at M.I.T., is "where some of our problems start."

For example, Dean Keil told the M.I.T. Alumni Advisory Council early this spring, all the technological solutions we now propose to the "energy problem" have to do with how to make more energy (albeit with less environmental hazard). Instead, we should be looking at how to decrease demand: how to insulate houses better, how to make machines more efficient, how to substitute low-energy-using devices for more extravagant alternatives.

"The tragedy of our time," said Dean Keil, " is that we have developed a cult of technology, not a technological culture."—*J.M.*

A New Catalyst for Technology Transfer

How can innovative technology be moved more effectively from college and university research laboratory—where it is presumably plentiful—to industrial use, where declining productivity suggests to some observers that technological innovation may be almost extinct?

For an answer to that question M.I.T. has turned to Richard S. Morse, Senior Lecturer in the Sloan School of Management, who is a passionate believer in the power of new technology to improve the competitive power of American industry and to create new jobs. The Executive Committee of the M.I.T. Corporation has named him President of a new M.I.T. Development Foundation, Inc., and Dr. Morse is now well into the task of raising the $250,000 ($50,000 of initial funds have been provided by M.I.T.) which will put the Foundation into the business of catalyzing reactions between M.I.T. research and U.S. industrial practice.

Its prospectus describes the goals of the M.I.T. Development Foundation, Inc., to "assist in the generation of new enterprises, and to serve as a communication link between government, industry, and venture capital sources as they may be interested in M.I.T. technology and other activities."

As a tax-exempt organization supporting M.I.T., the Foundation will receive funds from both industry and government to support research; it will work with M.I.T. and other interested institutions concerned with the public and industrial use of technology; and it may make modest investments in new ventures, acquiring donations from M.I.T. alumni and others in the "new enterprise community."

But it will not, according to Dr. Morse, "directly engage in business operations."

Specifically, the Foundation—a unique experiment in developing a community of interest between academic research and industrial need—intends to:

☐ Develop better understanding of how science and technology are applied and study innovative management mechanisms for improving such applications.

☐ Seek gifts and grants from individuals, venture capital organizations, financial institutions, and industries interested in the technology transfer process and in the generation of new, technically based business enterprises.

☐ Promote public and industrial applications of developments by M.I.T. faculty, staff, and laboratories.

☐ Expedite the generation of new business enterprises by serving as a communication link between M.I.T. personnel and laboratories on the one hand and entrepreneurs, managers, venture capital sources, and industry on the other.

☐ Help members of the M.I.T. community exploit commercial applications of technology with advice in such areas as marketing, management, personnel, patents, business planning, and finance.

In his initial prospectus for the Foundation, Dr. Morse notes that there are ample resources for exploitation. Including the Lincoln Laboratory and the Charles S. Draper Division, he writes, M.I.T. has 4,500 people—some 1,700 professionals—engaged in science and engineering research and development activities. "A program of this magnitude would normally be associated with an industrial organization with some 200,000 employees," Dr. Morse writes.

He believes that appreciation of over $500 million in venture capital portfolios within the last five years can be assigned to investments in new technology "in some way associated with M.I.T." Yet Dr. Morse suggests that the Institute itself has gained but little from this outpouring of innovation; and he believes in any case that only a fraction of the available potential has been realized.

President Jerome B. Wiesner agrees. In the news release announcing the Foundation, he speculates that "too often good ideas languish for want of proper impetus. We hope this new organization will help overcome this kind of inertia."

Pending election of a full board of directors for the new organization, the Executive Committee of the M.I.T. Corporation has appointed three initial Directors: Carl M. Mueller, Senior Partner in Loeb, Rhoades and Co.; Albert G. Hill, Vice President for Research at M.I.T.; and Dr. Morse.—*J.M.*

The Fading of New England Enterprise

The flowering of high-technology entrepreneurship in New England which began 30 years ago may now be ending, says Edward B. Roberts, Professor of Management at M.I.T.

The innovative style achieved by spin-off companies in New England in the 1950's populated the famous Route 128 with high-technology enterprise. Now it's different: innovation is staying within the company where it is inspired—and since most companies big enough to generate innovative ideas are national companies, the effect is that a peculiarly New England (and San Francisco-Palo Alto and Ann Arbor-Detroit) phenomenon seems to be ending.

But in no other respects is innovative entrepreneurship different today from that which he and his colleagues studied in New England beginning early in the 1950's (*see "How To Succeed in a New Technology Enterprise" by Edward B. Roberts in* Technology Review *for December, 1970, pp. 22-27*), Professor Roberts told a meeting of New England executives at M.I.T. late last fall. The successful innovator "is still a general-purpose entrepreneurial man" who has a feel for sales and management as well as technology, and the problem today seems to be that New England firms fail to create the conditions under which such a creative man can thrive.

These conditions for innovation, said Professor Roberts, are:

☐ Use measures of performance which recognize the true value of innovation to a company.

☐ Make internal mobility easy, so that creative men can move within a company to seek colleagues and an environment where their new ideas will be most fruitful.

☐ Be sure employees are able to take responsibility for working out the ideas they have.

☐ Set up some kind of internal "venture capital" system so that innovative ideas can be funded in accordance with their potential. "Most of you have internal money monopolies," Professor Roberts told his audience of New England executives.

☐ When a promising new innovation is identified, give it support from the marketing and financial management of the company as well as from the research and development group.

☐ Don't write off a new idea just because it seems to have a small potential market. Rate of return on investment—profitability—should be the criterion.

In a nutshell, said Professor Roberts, if a company wants to keep a creative man it should be prepared to give him the same kind of environment which he would try to create if he went out on his own.

The bigger a company, the harder is this advice to follow. Describing his own implementation of this philosophy as head of an "innovation center" for Cabot Corporation (National Research Corp.), Charles C. Shoup, its Vice President and General Manager, noted a major hazard: Large companies tend to be conservative; they have found dependable routes to profit, and their inclination is to follow them without taking the risks that accompany any innovative product. But a small company has no choice: it must take risk if it wants to grow.—*J.M.*

Educational Autos

In 1968 Wally Rippel, a student at Cal-Tech, challenged a group of students at M.I.T. to build an electric car to run a transcontinental race against the electric car he had built. That was the Great Electric Car Race. Then in 1970, a student group based at M.I.T. held a larger race, open to any car entered by college students that could meet 1975 federal pollution standards; there was still a transcontinental test, but other factors like pollution levels, noise, and maneuverability were also counted. That was the Clean Air Car Race.

Neither of those events produced the ultimate automobile, but both were challenging and fun for the students who participated. That philosophy—that designing and building a new kind of car is a worthwhile educational experience—has motivated yet another intercollegiate competition, the Urban Vehicle Design Competition, planned for August, 1972.

Instead of testing the 45 or so expected final entries on a transcontinental rally, this year's competition will focus on the problems of in-town driving. Those include not only exhaust emissions but also safety, cost to the consumer, handling, acceleration, braking, noise, parkability, driveability, interior space utilization, repair cost after a five mile per hour collision, energy efficiency (gas mileage), and size. The main battery of tests will take place from August 9 to 11 at the General Motors Proving Grounds in Milford, Mich.

"I was bored with engineering when we started this, and so were most of the other students on the committee," says M.I.T. senior Vincent S. Darago, the U.V.D.C.'s coordinator. "That's why we had so much free time to spend on this. . . . One of our main goals is to give engineering students something they can get interested in."

The U.V.D.C. is sponsored by a nonprofit corporation known as S.C.O.R.E. (for Student Competitions on Relevant Engineering, Inc.), an organization directed by the deans of engineering at nine U.S. universities and whose purpose is to sponsor intercollegiate engineering competitions like this one.

The U.V.D.C. is being particularly careful to discourage industrial participation. Students can receive money and advice from industry, but the use of industrially-designed or manufactured systems will cause them to lose points in the competition.

Mr. Darago estimates that by its completion, the U.V.D.C. will have involved 2,200 engineering students. Not all of the designs will be realized and not all the prototypes will make it to the competition, but the students will still have benefitted.

And their imagination is impressive, as demonstrated by their design proposals. Powerplants include internal-combustion engines burning a variety of fuels in both piston and Wankel configurations, various external combustion engines, one flywheel-powered vehicle, and several electric and electric-hybrid vehicles. There will also be a variety of transmissions and power trains, along with novel designs for bodies, bumpers, and other safety features.—*R.A.*

The Bus Starts Looking Good

The northern line of the Boston subway ends in Harvard Square, the train doors open, and hundreds of people go up into the Square or down a passage to the busses. Busses pull alongside the curb every 30 seconds during rush hours, to fan out into Arlington, Watertown, Medford, all of the northern suburbs. Some 26,400 people a day take the bus out of Harvard Square.

With or without a subway, the bus gets a lot of people around in the cities. At times it is slow, at times inconvenient; it is often deployed without imagination. Many planners and engineers have therefore conceived novel urban transit systems—sophisticated, expensive, and not yet running. The humble and steady bus may still be the best bet: so said A. Scheffer Lang, professor of civil engineering, to a seminar here last fall.

We cannot build expressways with our former abandon, he said. Yet the alternative, public transit, is in as much difficulty as ever. New York City voted down a $500 million bond issue without which Mayor Lindsay said he could not maintain a 30¢ subway fare. And Seattle, Los Angeles, Atlanta, St. Louis, and the Twin Cities are all moving towards a rail transit system at an exceedingly temperate pace.

Of the new technologies offered, Dial-a-Ride (see *Technology Review*, January, 1972, p. 69) is closest to being installed, but it is appropriate to a medium-density area, not an urban one. Personal Rapid Transit systems (in which one or a few persons ride in a small car over an automated guideway) will likewise satisfy only a small part of the need for public transportation. Once, Professor Lang said, he and other engineers saw those new systems as promising; but they are proving significantly more expensive than once they seemed.

The most progress in urban transit has come, he said, from increased and more imaginative use of conventional buses.

The highway system may be serving our cities quite well. Of all the urban systems he has surveyed, says Professor Lang, the highway—with improvements—seems the best one to meet our social goals "to let an individual citizen make and meet the social opportunities that suit him best."

Professor Lang made two more points: many planners and engineers are beginning to believe that the problems of getting around in the city are institutional rather than technical; and urban congestion is historically a self-rationing kind of problem—it does not increase indefinitely, because as it grows worse, more people choose to stay out of it. (Charles L. Miller, Director of M.I.T.'s Urban Systems Laboratory, proposes a Parkinsonian law of road transport: congestion will always increase to the level of inconvenience. He cites a study which showed that the level of congestion on Massachusetts Avenue, Boston/Cambridge, had remained constant for 40 years.)—*J.K.*

The Oil and Auto Imperative

If the past five years are any guide, the next 12 to 14 will see a doubling of oil consumption in the United States, and a substantial increase (how much is harder to estimate) in the number of automobiles on the road.

The reaction of former Secretary of the Interior Stewart Udall to these predictions is blunt: "I don't think it's in the cards." Invited to speak at M.I.T. by the New England Consortium on Environmental Protection, Mr. Udall stated that the petroleum industry's own figures indicate oil production in the United States has peaked out already. Because of limited land-bound resources and nearly unanimous opposition to new off-shore drilling, Mr. Udall does not expect domestic production to ever again reach the 1971 level.

What is more likely to occur, he said, is an increase in Middle East oil importation, followed shortly thereafter by nationalization of the Middle Eastern oil industry.

"It all adds up to limits," he said—if only to maintain self-sufficiency and provide a share of oil for future generations. As a drain on resources, Mr. Udall singled out the automobile, calling it "far and away the most destructive influence on American life. . . . If we could make a sober analysis, we would level off the automobile population in this country," he said. "I'm convinced of this."—*Michael Chiusano*

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The tour program covers areas where those who might otherwise prefer to travel independently will find it advantageous to travel with a group. The itineraries have been carefully constructed to combine the freedom of individual travel with the convenience and savings of group travel. There is an avoidance of regimentation and an emphasis on leisure time, while a comprehensive program of sightseeing ensures a visit to all major points of interest. Hotel reservations are made as much as a year and a half in advance to ensure the finest in accommodations.

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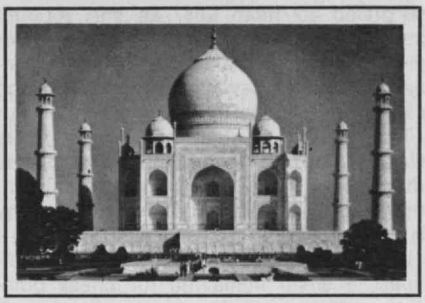
A luxury "safari" to the great national parks and game reserves of Uganda, Kenya and Tanzania. The carefully planned itinerary offers an exciting combination of East Africa's spectacular wildlife and breathtaking natural scenery: great herds of elephant and a launch trip through hippo and crocodile in **MURCHISON FALLS NATIONAL PARK;** multitudes of lion and other plains game in the famed **SERENGETI PLAINS** and the **MASAI-MARA RESERVE;** the spectacular concentration of wildlife in the **NGORONGORO CRATER;** tree-climbing lions around the shores of **LAKE MANYARA;** the **AMBOSELI RESERVE,** where big game can be photographed against the towering backdrop of snow-clad Mt. Kilimanjaro; and the majestic wilds of **TSAVO PARK,** famed for its elephant and lion as well as its unusual Mzima Springs. Also included are a cruise on **LAKE VICTORIA** in Uganda and visits to the fascinating capital cities of **KAMPALA** and **NAIROBI.** The altitude in East Africa provides an unusually stimulating climate, with bright days and crisp evenings (frequently around a crackling log fire), and the tour follows a realistic pace which ensures a full appreciation of the attractions visited. Total cost is **$1699** from **New York.** Optional extensions are available to the famed **VICTORIA FALLS,** on the mighty Zambezi River between Zambia and Rhodesia, and to the historical attractions of **ETHIOPIA.** Departures in January, February, March, May, June, July, August, September, October, November and December 1972 ($25 additional for departures in June, July, August).



THE ORIENT

30 DAYS $1759

1972 marks the eighth consecutive year of operation for this outstanding tour, which offers the greatest attractions of the Orient at a sensible and realistic pace. Twelve days are devoted to the beauty of **JAPAN,** visiting the ancient "classical" city of **KYOTO,** the modern capital of **TOKYO,** and the lovely **FUJI-HAKONE NATIONAL PARK,** with excursions to ancient **NARA,** the magnificent medieval shrine at **NIKKO,** and the giant Daibutsu at **KAMAKURA.** Visits are also made to **BANGKOK,** with its glittering temples and palaces; the fabled island of **BALI,** considered one of the most beautiful spots on earth; the ancient temples near **JOGJAKARTA** in central Java; the mountain-circled port of **HONG KONG,** with its free port shopping; and the cosmopolitan metropolis of **SINGAPORE,** known as the "cross-roads of the East." Tour dates include outstanding seasonal attractions in Japan, such as the spring cherry blossoms, the beautiful autumn leaves, and some of the greatest annual festivals in the Far East. Total cost is **$1759** from **California, $1965** from **Chicago,** and **$2034** from **New York,** with special rates from other cities. Departures in March, April, June, July, September and October 1972.

AEGEAN ADVENTURE

22 DAYS $1329

This original itinerary explores in depth the magnificent scenic, cultural and historic attractions of Greece, the Aegean, and Asia Minor—not only the major cities but also the less accessible sites of ancient cities which have figured so prominently in the history of western civilization, complemented by a luxurious cruise to the beautiful islands of the Aegean Sea. Rarely has such an exciting collection of names and places been assembled in a single itinerary—the classical city of **ATHENS;** the Byzantine and Ottoman splendor of **ISTANBUL;** the site of the oracle at **DELPHI;** the sanctuary and stadium at **OLYMPIA,** where the Olympic Games were first begun; the palace of Agamemnon at **MYCENAE;** the ruins of ancient **TROY;** the citadel of **PERGAMUM;** the marble city of **EPHESUS;** the ruins of **SARDIS** in Lydia, where the royal mint of the wealthy Croesus has recently been unearthed; as well as **CORINTH, EPIDAUROS, IZMIR** (Smyrna) the **BOSPORUS** and **DARDENELLES.** The cruise through the beautiful waters of the Aegean will visit such famous islands as **CRETE** with the Palace of Knossos; **RHODES,** noted for its great Crusader castles; the windmills of picturesque **MYKONOS;** the sacred island of **DELOS;** and the charming islands of **PATMOS** and **HYDRA.** Total cost is **$1329** from **New York.** Departures in April, May, July, August, September and October, 1972.

MOGHUL ADVENTURE

29 DAYS $1725

An unusual opportunity to view the outstanding attractions of India and the splendors of ancient Persia, together with the once-forbidden mountain kingdom of Nepal. Here is truly an exciting adventure: India's ancient mounuments in **DELHI;** the fabled beauty of **KASHMIR** amid the snow-clad Himalayas; the holy city of **BANARAS** on the sacred River Ganges; the exotic temples of **KHAJURAHO;** renowned **AGRA,** with the Taj Mahal and other celebrated monuments of the Moghul period such as the Agra Fort and the fabulous deserted city of Fatehpur Sikri; the walled "pink city" of **JAIPUR,** with an elephant ride at the Amber Fort; the unique and beautiful "lake city" of **UDAIPUR;** a thrilling flight into the Himalayas to **KATHMANDU,** capital of **NEPAL,** where ancient palaces and temples abound in a land still relatively untouched by modern civilization. In **PERSIA** (Iran), the visit will include the great 5th century B.C. capital of Darius and Xerxes at **PERSEPOLIS;** the fabled Persian Renaissance city of **ISFAHAN,** with its palaces, gardens, bazaar and famous tiled mosques; and the modern capital of **TEHERAN.** Outstanding accommodations include hotels that once were palaces of Maharajas. Total cost is **$1725** from **New York.** Departures in January, February, August, October and November 1972.

Rates include Jet Air, Deluxe Hotels, Most Meals, Sightseeing, Transfers, Tips and Taxes. Individual brochures on each tour are available.

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(Continued from page 9)
season, the creatures would spring to life, multiply, and return to dormancy. There is an analogy on Earth. On mountains in Antarctica, only 400 miles from the South Pole, tiny mites have been found which get all the business of life done in a month or two in tiny pools of melt-water. Is it possible that the pair of Viking craft, designed to land on Mars around July 4, 1976, could spot evidence of such creatures?

And Now to Study the Sun

When Mariner went into orbit around Mars last November, Earth and Mars were only 75 million miles apart, and so radio signals took only about seven minutes to reach the 210-foot antenna at Goldstone, Calif., from the one-meter antenna perched on top of Mariner 9.

But Earth was pulling ahead of Mars on the inside track. With every day, the distance increased, and so did the angle between the axis of the Mariner 9 antenna and the line of sight to Earth. On April 2, Mariner 9's orbit began to fall into the planet's shadow for a few more seconds on each pass. Each time the craft passed into shadow, it suffered the "thermal shock" of passing into extreme cold, and used some of electricity stored in its batteries by the power-generating solar cells. Transmission was stopped to save energy.

Once the period of shadowing is past, however, by early summer, Mariner 9 is to deliver one or two orbit's worth of scientific data to Earth each week. Meanwhile, the Earth's more rapid motion around the sun will carry it around to a point on the opposite side of the sun from Mars September 7. This point is called "superior conjunction." The two planets will be 240 million miles apart.

For a week before and after superior conjunction, radio signals from Mariner 9 will be passing within a few degrees from the sun, and through its corona. The behavior of the signals will probe the violently moving clouds of particles in the corona, and test further Einstein's predictions of the effect of gravity on light.

The Many-Royalty Problem

Puzzle Corner:
Allan J. Gottlieb

Many people sent very thoughtful letters to Alice and me wishing us well and including an occasional tip for a successful marriage. So far everything is working out fine; and we are, of course, very greatful (sic., but a feminine hand corrected it to *grateful*—Ed.) to everyone who corresponded. (Perhaps sparked by our success, Doug Friedman, an old roommate, is marrying Bonnie Koski in June.)

On the home front, Alice and I are planning an Hawaiian vacation for this summer. We are a little excited, and now "surfing" music emanates daily from the old hi-fi.

We were discussing chemistry labs today, and I mentioned that in weighing precipitates I used a balance where one manually adds small brass weights (masses?) to one pan. Alice was a little surprised to hear this, as she thought such balances went out with steam locomotives—another example of the "generation gap" a seven-year age difference can bring.

To answer a frequent question, a Harry Nelson "puzzle invention" is a puzzle (hand held, requiring thought, manipulation, but no calculations) invented by Harry Nelson.

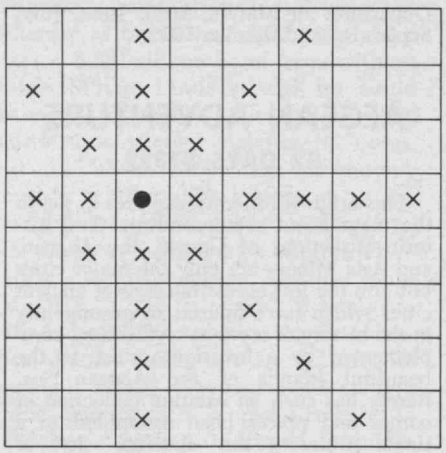
I have received an issue of *Chess Ultimate,* a small magazine for chess positions which maximize (or minimize) various chess phenomena. Anyone interested should contact the Editor, Thur Row, at 12039 Gardengate Drive, St. Louis, Mo., 63141.

Send problems and solutions to me at the Department of Mathematics, University of California, Santa Cruz, Calif., 95060; we pick one solution to publish and note the names of others who submitted solutions. Following the suggestion of Smith D. Turner ($\int dt$), I will say if "also solved by 's' " are different solutions from that published.

Problems

Our first problem has three parts—the first an old chess problem, and the next two mathematical generalizations; it comes from Dr. Benjamin Whang:

JN-1 (a) On a chess board, place eight Queens such that no Queen is vulnerable to other Queens—i.e., no Queen should be in the path of other Queens. (For those who do not play chess: on an 8×8 grid, place eight dots, one on each row, such that no two dots have the same column or same diagonal. For example, once a dot is placed as shown below, the spaces marked "x" are taboo for other dots.)



(b) Obtain a general pattern (or two) for placing $2n$ dots in a grid $2n \times 2n$ ($n > 1$), with the same restriction as above.

(c) Extend the solution for (b) for placing n dots in a grid $n \times n$ ($n > 3$).

This number-theoretic problem is from Mrs. H. E. Schabacker:

JN-2 What simple rule governs this sequence?

1,1,2,1,2,1,2,3,1,3,2,1,2,3,
3,1,3,2,1,3,2,3,4, . . .

Here's a complicated-looking algebraic formula from Greg Schaffer:

JN-3 Show or prove that

$$\left(\frac{1-x}{1+x}\right)(2x+1)\prod_{k=1}^{\infty}\left\{[1+x^{2k}]\left[1+\left(\frac{x}{1+x}\right)^{2k}\right]\right\} = 1$$

A cute, somewhat well known problem from Roy Sinclair:

JN-4 You are given as many playing cards as you wish to use, each of length a and width b. They are stacked one upon another in the usual way, so that each card is in contact with only the cards immediately above and below it, with the objective of achieving the maximum overhang before they fall over. What is the length of this overhang?

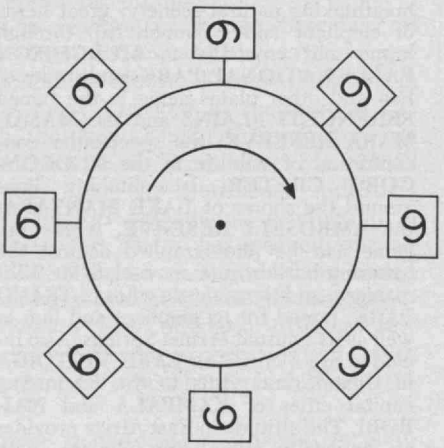
One of those "plug-in-numbers-for-letters" puzzles from R. E. Crandall:

JN-5 Find the cube root of INVENTORY and verify it can be eaten or drunk.

Speed Department

This is hardly a problem, but I cannot resist printing it—from Kenneth Morgan: he writes:

SD-1 "I have had a perpetual motion machine (below) working satisfactorily for years. Somehow I have a feeling that the Morris Markovitz machine and mine have similarities. (Six-pound weights automatically become nine-pound weights on the right side. There is no limit to the power that can be developed by this machine; for instance, try using 6,666-lb. weights)."



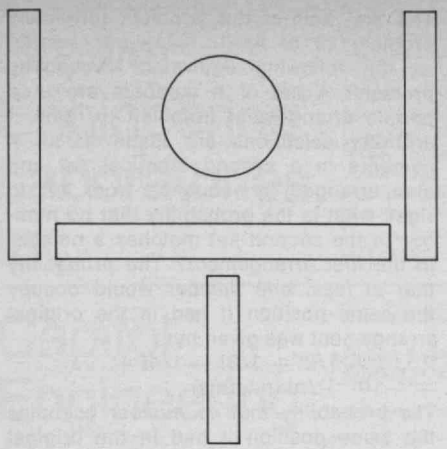
A pencil-pushing problem from Les Servi:

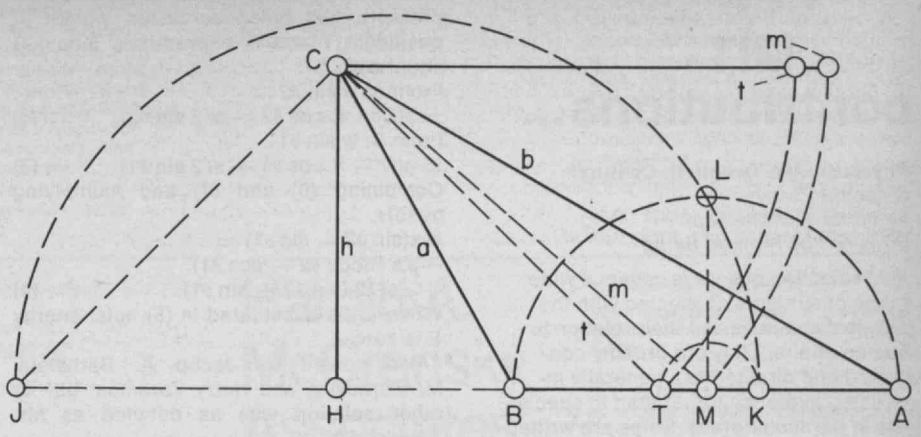
SD-2 With four pencils and one penny in the formation shown, move just two pencils to make the penny no longer in the cup. (See diagram on p. 71 top.)

Solutions

The following are solutions to problems published in *Technology Review* for February:

61 Set up chess pieces as though to start a game. White *must,* in proper sequence, make the following four moves: 1. P—KB3; 2. K—B2; 3. K—N3; 4. K—R4. What are the four legal moves to be made





by Black after which White is checkmated?

The following solution is from Abraham Schwartz:

The problem has one general solution with two key moves:

1. P—KB3; Black moves P—K3 *or* P—K4.
2. K—B2; Black moves Q—B3.
3. K—N3; Black moves Q × P +.
4. K—R4; Black moves B—K2. Mate.

The solution is easy from the chess point of view but psychologically hard since one doesn't look for Q × P +; it is somewhat similar to a helpmate problem.

Also solved by Allen Andersson, Robert B. Anthonyson, Bill Cain, Claude W. House, Richard Jenney, John L. Joseph, Marc Judson, Chip Melvin, Russell A. Nahigian, E. A. Nordstrom, Hunter Platt, and Mike Rolle.

62 Given line segments of length h_c, t_c, and m_c, construct a triangle such that the altitude has length h_c, the angle bisector has length t_c, and the median has length m_c when these three lines emanate from the same angle.

The following is from R. Robinson Rowe:

Given h, t, and m concurrent at C, construct triangle ABC. (See diagram at top right.)

With CH = h, draw the perpendicular at H as the base of the triangle. Draw arcs with radii t and m to the base at T and M. Draw the bisector CT and the median CM. Draw CJ perpendicular to CT to the base at J. On the base, lay off MK = MT. On diameter JK, draw arc JLK. Draw ML perpendicular to the base, intersecting semicircle JK at L. With M as the center and ML as the radius, draw semicircle ALB intersecting the base at A and B. Draw AB, BC, and CA; ABC is the required triangle. *Proof*: Let a = BC, b = AC, c = AB, d = BT, e = AT, f = MT, g = HM, h = CH, and i = HT. Then

$a^2 = h^2 + (g - \frac{1}{2}c)^2$,
$b^2 = h^2 + (g + \frac{1}{2}c)^2$,
bd = ae, c = e + d, and
2f = e − d = 2(g − i).

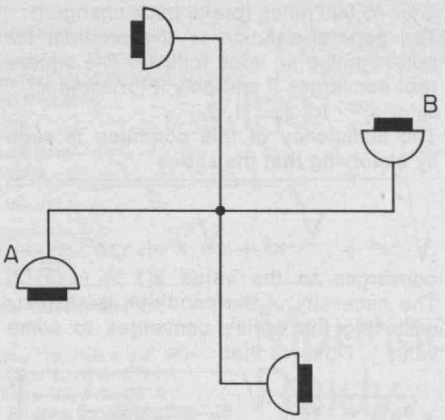
Eliminating unknowns a, b, d, and e, we get

$(\frac{1}{2}c)^2 = f(g + h^2/i)$.

By construction $JH = h^2/i$,
$JM = g + h^2/i$,
MK = f, and $\overline{ML}^2 = JM \cdot MK$.
So ML = ½c = MA = MB.

Also solved by Richard Jenney, Raymond Gaillard, John L. Joseph, Mary Lindenberg, P. Markstein, and Mike Rolle; all solutions are, at least slightly, unique.

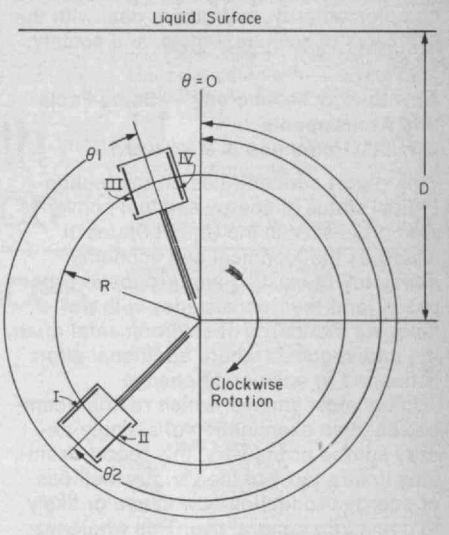
63 The "ferris wheel" (below) is constructed under atmospheric pressure. Metal cups are attached to each arm, and a pliable membrane seals the top of each cup. Glued to the center of each membrane is a weight. The "ferris wheel" is now submerged in water. The weight at cup A stretches the membrane, increasing that cup's volume. The weight at cup B compresses that cup's volume. Thus, cup A is more buoyant and the "wheel" rotates in a clockwise direction forever.



A magnificent solution has come from T. Davidson who writes that he built such a machine some 60 years ago and "can assure you with no success. The obvious reason for failure is that energy to raise liquid from the lower expanding chamber to the upper contracting chamber must come from somewhere." Here is his mathematical "proof" (those quotation marks are his):

Some liberties have been taken with the design:

1. The cups have been replaced by cylinders with "frictionless" pistons, as it is easier to visualize how their expansion and contraction occurs.
2. The surface area of the liquid is assumed to be large enough that the depth D is not changed appreciably by the expansion and contraction of cylinders which do not occur simultaneously.
3. The residual air volume is assumed to be large enough that piston movement is not affected appreciably by changes of air pressure as the cylinder volume expands or contracts.
4. The pistons are assumed to be held at both inner and outer positions by "frictionless" latches, for mechanical release at the angular position at which the balance of piston weight and liquid pressure will just achieve full stroke.



ρ = liquid density, positive downward
w = piston weight, positive downward
s = piston stroke, from closed end; piston area = 1
E = energy, positive clockwise
The weight of cylinder and support can be neglected.

Rotation clockwise from θ1 to θ2:

$E = w[R(\cos\theta 1 - \cos\theta 2) - s/2(\sin\theta 1 - \theta 2]$ (1)

Unbalanced piston force from I to II:

At I = $w \sin\theta 2 - \rho(D - R\cos\theta 2 + s/2 \sin\theta 2)$
At II = $w \sin\theta 2 - \rho(D - R\cos\theta 2 - s/2 \sin\theta 2)$ (A)
Net average = $\rho s/2 \sin\theta 2$
$E = \rho s^2/2 \sin\theta 2.$ (2)

Rotation clockwise from θ2 to θ1:

$E = w[R(\cos\theta 2 - \cos\theta 1) + s/2(\sin\theta 2 - \sin\theta 1) - \rho s R(\cos\theta 2 - \cos\theta 1)]$ (3)

Unbalanced piston force from III to IV:

At III = $w \sin\theta 1 - \rho(D - R\cos\theta 1 - s/2 \sin\theta 1)$
At IV = $w \sin\theta 1 - \rho(D - R\cos\theta 1 + s/2 \sin\theta 1)$ (B)
Net average = $\rho s/2 \sin\theta 1$ (4)
$E = \rho s^2/2 \sin\theta 1.$

Total energy in one revolution (eq. 1 + 2 + 3 + 4):

$E = w s(\sin\theta 2 - \sin\theta 1) + \rho s R(\cos\theta 2 - \cos\theta 1) + \rho s^2/2 (\sin\theta 2 + \sin\theta 1)$ (5)

If $\theta 1$ and $\theta 2$ are the angles at which liquid pressure just balances piston weight at positions IV and II, expressions A and B equal zero, or:

From A: $w \sin \theta 2$
$= \rho(D - R \cos \theta 2 - s/2 \sin \theta 2)$ (6)

From B: $w \sin \theta 1$
$= \rho(D - R \cos \theta 1 + s/2 \sin \theta 1)$ (7)

Combining (6) and (7) and multiplying by (5):

$w\, s(\sin \theta 2 - \sin \theta 1) =$
$-\rho\, s\, R(\cos \theta 2 - \cos \theta 1)$
$- \rho\, s^2/2\, (\sin \theta 2 + \sin \theta 1)$ (8)

When (8) is substituted in (5), total energy E is zero.

Also solved by Jacob A. Bernstein, M. Markovitz, and Harry Zaremba; but no other solution was as detailed as Mr. Davidson's.

64 Consider the infinitely nested square root

$$\sqrt{a_1 + \sqrt{a_2 + \sqrt{a_3 + \dots}}}$$

Prove that the nest converges when $a_n = n$. Does it converge when $a_n = n^2$? $n!$? How about when $a_n = (n^2!)^{n^2}$?

Here is a solution from Mike Rolle, who thanks me for recommending that he buy a Volvo 122S. He did, and after almost 100,000 miles it's still running well (with original brake pads). My 122S, which tempted Rolle to buy his, was wrecked after 45,000 miles (brake pads changed).

The general solution to the problem for non-negative a_n is as follows: The square root converges if and only if for some x, $a_n \leq x^{(2^n)}$ for $n = 1, 2, \dots$

The sufficiency of this condition is seen by observing that the series

$$\sqrt{x^2 + \sqrt{x^4 + \sqrt{x^8 + \sqrt{x^{16} + \dots}}}}$$

converges to the value $x(1 + \sqrt{5})/2$. The necessity of the condition is seen by assuming the series converges to some value y. Observe that

$$\sqrt{a_n + \dots} \leq \left[\sqrt{a_{n-1} \pm \sqrt{a_n - \dots}}\right]^2$$

Therefore it folows that

$$a_n < \left[\sqrt{a_n - \sqrt{\dots}}\right]^2 \leq y^{(2^n)}$$

by induction.

Since $k! \leq k^k$ for any k, we estimate that $(n^2!)^{n^2} \leq n^{2n^4}$

The 2^n-th root of this is $n^{(n^4/2^{n-1})}$.

It should be clear that this expression goes to 1 as $n \to \infty$, and therefore has a maximum value x. Therefore,

$(n^2!)^{n^2} \leq x^{(2^n)}$

and the square root converges in this case. Certainly this is the worst case of these mentioned in the problem, and so all the other sequences for a_n also converge.

Also solved by R. Robinson Rowe and Stephen Scheinberg, whose solutions look different.

65 In how many different ways can n numbers be rearranged such that no number occupies its original position; and what fraction of the arrangements possible meet the additional criterion of having every digit change its position? In other words, does the sequence $a_n = k_n/n!$ converge?

The following is from Harry Zaremba:

The first half of this problem (originally problem 29 of April, 1971) was treated as the following equivalent probability problem: A set of n numbers are in a certain arrangement from left to right. If arbitrary selections are made of all n numbers in a second identical set and also arranged in sequence from left to right, what is the probability that no number in the second set matches a number in the first arrangement? The probability that *at least one number* would occupy the same position it had in the original arrangement was given by:

$P = 1 - 1/2! + 1/3! - 1/4! + \dots$
$+ -1^{(n+1)}/n!$ (n terms)

The probability that *no number* occupies the same position it had in the original arrangement is the complement probability of P:

$P' = 1 - P = k_n/n!$
$= 1 - (1 - 1/2! + 1/3!$
$- 1/4! + \dots + -1^{(n+1)}/n!)$

or,

$k_n/n! = 1/2! - 1/3! + 1/4! - \dots$
$- -1^{(n+1)}/n!$ (n − 1 terms)

where k_n is the number of different ways n numbers can be arranged where no number matches its original position and n! is the total number of different ways (permutations) n numbers can be arranged. When $n \to \infty$, the ratio $k_n/n!$ converges to e^{-1}.

Also solved—in the same way—by Judith Q. Longyear, Mike Rolle, and R. Robinson Rowe.

Better Late Than Never

45 Solutions have come from Norman Brenner and Everett A. Potter.

Hervé Thiriez has supplied solutions to problems **53** and **55**, and Stephen Bryant to problem **54**.

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Frustration and Protest—1972

As U.S. action against North Vietnam escalated in April and May, campus anti-war actions—both violent and non-violent—reasserted themselves. But most observers felt that the disruptive impact at M.I.T. was smaller than in 1969-1970.

Anti-war activities shook the M.I.T. campus again this spring after a two-year interlude. The stimulus this year was the bombing and mining of North Vietnam; two years ago it had been the Cambodian invasion and the Kent State killings.

Reactions were as varied as ever. Some marched, some canvassed, some wrote letters, some sat-in, and some organized those activities. Some demanded an end to M.I.T.'s alleged complicity in the war, and some tried to force an end to that complicity. Most things had been done before, sometimes by the same people.

M.I.T. showed its concern but clung to its pluralism. President Jerome B. Wiesner early joined the presidents of the ivy league universities deploring the renewed bombing of North Vietnam and endorsing non-violent, constructive forms of protest. And the faculty passed resolutions urging a quick end to the war, then moved to ease the academic burden for those students whose consciences moved them to action.

Then President Nixon announced the mining of North Vietnamese waters, and the scenario was repeated with some added intensity. There were renewed protests, a pitched battle between riot police and demonstrators (most of them not affiliated with M.I.T.), new faculty resolutions, and a brief takeover of part of the R.O.T.C. offices.

* * *

"Strike!"—But What Did that Mean?

When the U.S. resumed bombing North Vietnam last April 16, there followed a national wave of protests, both violent and non-violent. One of the former caused major damage nearby at Harvard's Center for International Affairs on April 18. The next day President Wiesner and the ivy league presidents tried to indicate their position and to head off further violence by issuing their statement (see opposite).

On April 20, 500 to 600 met in Rockwell Cage and voted overwhelmingly to stage a protest strike—but the word "strike" was to remain undefined. Radicals, whose rhetoric tended to dominate this and subsequent meetings, demanded an end to specific M.I.T. activities which allegedly support the U.S. war effort.

The next morning there was a picket line in front of the Rogers Building entrance. Around noon, members of S.D.S. exhorted the 100 to 200 pickets to march to the Center for International Studies, the alleged scene of Pentagon-sponsored counterinsurgency research. There, a group attempted to force its way inside; there was pushing and shoving, but the group was turned away without violence.

Afterwards, M.I.T. Vice President John Wynne sent a letter to one of the more active participants in the shoving match, Paul Sedgwick, '71, forbidding him to again enter M.I.T. premises and threatening him with prosecution as a trespasser if he should do so. But the threat proved no deterrent, for Mr. Sedgwick later returned many times and was duly prosecuted.

The same day as the march to the C.I.S., April 21, Undergraduate Association President Curtis Reeves, '73, opened the polls for an undergraduate referendum on the strike. The results were: 188 for a one-day moratorium, 226 for a one-week strike, 531 for an open-ended strike, 21 for other strike formats, and 638 against any kind of strike. The turnout was large for an undergraduate election but small in absolute terms. Attendance in most classes was normal—surprising on a sunny spring Friday.

Monday, April 24, saw the resumption of the picket line and the establishment of a mock graveyard of crosses in the Kresge plaza. The first in a new series of bomb threats to the C.I.S. (where a bomb had gone off last fall) was phoned in.

"The Biggest War Criminal Around!"

Speakers in Building Seven harangued anyone who would listen; they said the faculty wanted a showing of student commitment before it would act. Much of the rhetoric was directed against alleged complicity in the war—R.O.T.C. and research at the C.I.S. and the still-undivested Draper Laboratories.

A number of speakers concentrated on Dr. Wiesner. Someone discovered a passage in the *Pentagon Papers* identifying him with a scientific group which in 1965 proposed a study of the feasibility of electronic detection methods for Vietnam. That suggestion supposedly led to the "electronic battlefield" concept. And, S.D.S. charged, Dr. Wiesner is a director of a company building electronic counter-measures equipment. These involvements, one speaker exclaimed, make Dr. Wiesner "the biggest war criminal around!"

That afternoon, Dr. Wiesner answered

President Jerome B. Wiesner (lower right, above) came to the Building Seven lobby on April 24 to answer protestors' angry questions about his and M.I.T.'s alleged complicity in the Vietnam war. Nearly three weeks later, after President Nixon's plan to mine North Vietnamese waters was announced, the M.I.T. West Campus became the stage for a clash between riot police and young people—probably including only a few M.I.T. students—intent on Cambridge violence (below). Though the police used tear gas abundantly and there was moderate vandalism on the campus, the course of events within the M.I.T. community was little changed.

the charges. He is a director of Adams Russell, he admitted, but he did not know about any of the company's specific projects. And the story from the *Pentagon Papers* had "some elements of truth in it:" Dr. Wiesner was one of a group of academics with government experience who were looking for alternatives to bombing in Vietnam. They suggested a study which eventually "made some proposals about electronic barriers," but Dr. Wiesner did not himself participate in the study.

Wednesday, April 26, began with about 80 demonstrators holding a somewhat unruly obstructive sit-in in front of the C.I.S. They demanded that all C.I.S. files be opened to inspection (to prove the claim that there is no counter-insurgency research done at the Center) and that M.I.T. immediately stop contracting for war related research. M.I.T. officials eventually threatened the demonstrators with prosecution for trespassing. After brief discussions among themselves, the demonstrators dispersed.

Allowing "Maximum Flexibility"

The next day the director of the C.I.S., Professor Eugene B. Skolnikoff, '49, appeared before a crowd of several hundred in Kresge Auditorium. The protesters charged that C.I.S. research helps the U.S. government suppress popular rebellions around the world. Proof of this, they claimed, is the funding the Center receives from the Pentagon's Advanced Research Projects Agency. And though they do it on their own time, C.I.S. professors consult for some of the "most repressive" agencies of the U.S. government.

But Professor Skolnikoff maintained that though in the 1950's and 1960's the C.I.S. conducted secret research for the Central Intelligence Agency, it is now an open place where an ideologically heterogeneous group of scholars conduct unclassified research.

Friday, April 28, the faculty at a special meeting passed resolutions urging the U.S. "to get out of this war as fast as possible" and urging individual professors to "allow maximum flexibility of academic schedules during the current crisis." The faculty refused to suspend classes or make them optional, or to allow students to opt for a pass/fail grade or to delay the completion of the term's work until the next semester. It voted down a motion condemning R.O.T.C. and refused to act on another which condemned war research.

By this time, the most committed peace activists were lobbying in Washington or canvassing off-campus. Those who were left were studying for the upcoming examinations or otherwise conducting business as usual; classes had continued through the entire period.

For a week it appeared that the excitement had passed.

The A.E.W. and the "Attica Brigade"

But on Monday, May 8, President Nixon announced the mining of North Vietnamese harbors; the campus was again aroused, and by May 9 the first in a new series of mass meetings was held in Kresge Auditorium.

But these meetings were different from those of two weeks earlier. No longer was S.D.S. the only group with a coherent, highly visible activist program. A group working with Professor Edward Fredkin, Director of Project MAC, evolved into the "Army to End the War." Espousing "efficiency, discipline, and nationwide organization," it promised to "forever disassociate itself from any members or affiliated groups that engage in illegal or violent activity." But after its first week of existence, the A.E.W. had only 20 to 30 signed up members, about ten of whom could be called extremely active.

The more radical students tended to agree with Paul Sedgwick that "the best way to stop the war machine is to start right here at M.I.T. and stop the machinery they have on this campus!" A "militancy committee" was formed to plan militant protests.

But an unforeseen, unrelated incident intervened Thursday afternoon, May 11, when a group calling itself the "Attica Brigade" marched across the Harvard Bridge from a Boston peace rally. Its announced aim was to obstruct the Penn Central tracks at the northern edge of the campus in a form of retaliatory blockade.

Arriving at about 5:30, the 400-odd demonstrators blocked Massachusetts Avenue traffic, scattered debris onto the railroad tracks, tore down a fence, and set small fires on the tracks and in an adjacent lumber yard. Riot police arrived and began using tear gas to drive the demonstrators away from the tracks and assure that they stayed out of Central and Harvard Squares. The demonstrators had no place to go except onto the M.I.T. campus.

So a crowd of 150 to 200—some demonstrators, some curious students—gradually came together in the Student Center area. Some of them set up a barrier of debris, street sign posts, and burning trash cans across Massachusetts Avenue. Volleys of tear gas scattered the demonstrators; then they regrouped, setting a pattern of action which was to continue—with M.I.T.'s austere walls as a television stage setting—for the next two hours. There was some "trashing" within the M.I.T. campus, with windows broken and walls spray-painted; damages were estimated at $15,000, mostly in the form of broken glass.

As demonstrators fled clouds of tear gas, police pursuit extended past the Student Center, around Kresge Auditorium, and toward McCormick Hall. Demonstrators threw rocks and returned gas canisters, and students on dormitory roofs jeered the police. On more than one occasion, the police used tear gas launchers to fire level at demonstrators and bystanders; this action accounted for most of the injuries (nine people were treated in the M.I.T. infirmary; the most serious injuries were a broken arm and a lacerated face). Police fired tear gas into the ground floors of the Student Center and of McCormick Hall, into which demonstrators and/or bystanders fled to escape the tear gas spreading across the lawns. Plainclothesmen chased spectators from the roof of Bexley Hall, a uniformed officer entered Baker House and made crude threats to residents there, and other officers broke a window and damaged the door of a fraternity house.

If one stood in the shelter of M.I.T.'s main buildings, it was easy to suspect the police of using more force than the situation justified; President Wiesner himself told the faculty on the following day that "we tried to persuade them to minimize the use of gas." But a Central Square merchant, reflecting on the broken and pilfered store window of two years ago, might have rejoiced in the policemen's zeal.

Occupying Building 20—Briefly

The following noon, Friday, May 12, M.I.T.'s own militants held a protest rally. They marched to the R.O.T.C. offices and 50 to 60 of them pushed and shoved their way past campus police and administration officials to begin an occupation of some of the offices. Support proved limited, and the occupants left the next morning. They swept out the offices and left them in fairly good order. Files had been opened but not extensively disturbed.

The protesters' demands had been: "(1) stop the war in Southeast Asia; (2) an end to all war related and counterinsurgency research at M.I.T. . . ; (3) . . . an end to all classified consulting by the faculty; (4) an end to R.O.T.C. on campus; (5) that all workers, students, and faculty at M.I.T. be able to work on anti-war activities without any loss in compensation (wages, salary, course credits, etc.), and with no punitive action taken by M.I.T.; and (6) that M.I.T. drop its actions against Paul Sedgwick or any other person involved in political actions at M.I.T."

One of the demonstrators explained in an interview that the occupation was meant not as a symbolic protest but "as an act of force against M.I.T." The Institute later initiated criminal, as well as internal discipline, proceedings against 29 of the occupiers whom M.I.T. officials could positively identify.

While the militants were establishing their occupation, the faculty was holding another special meeting to consider modifying the end-of-term procedures (one week of classes remained on the schedule, followed by final examinations) to help students who wanted to engage in political activities.

First, the faculty passed an intricately-worded resolution providing that (1) classes would continue; (2) students in good standing could, with the permission of their instructors, take a letter grade on the basis of work completed to date; and (3) students could, with the permission of their instructors, delay without penalty completion of the semester's work until October 22. The faculty then passed another resolution condemning all aid to the Thieu government and endorsing peace actions.

There were two new activities the following week. One was a protest fast by 40 or so who pledged to eat only protein, and the other was an economic boycott of Wonder Bread, a product of a wholly-owned subsidiary of I.T.T.

Paul Sedgwick was convicted on two counts of trespassing and planned to

appeal; he tried with only limited success to introduce political arguments in his defense, and he rejected Judge Lawrence P. Feloney's suggestion that he request a suspended sentence on the condition he stay away from M.I.T. Additional trespass charges connected with the R.O.T.C. takeover were still pending against him and 28 others.

Meanwhile, there were demonstrations in various off-campus locations, and the Army to End the War continued its organizational efforts. The militants held a peaceful sit-in outside the President's Office on May 17, and in its regular May meeting the faculty passed a resolution endorsing the administration's actions against the R.O.T.C. demonstrators.

College Heads' Statement

Following is a statement issued jointly on April 19 by the Presidents of the eight Ivy League universities and the Massachusetts Institute of Technology concerning the war in Vietnam and campus demonstrations protesting the war:

Although none of us can speak for his institution, all of us personally oppose a national policy which seems to be based on the belief that the United States must at almost any cost win the war in which it is engaged in Indochina. The cost of such a policy in human life and suffering is appalling and unjustified. We therefore deplore the bombing of North Vietnam and its civilian population.

America's withdrawal from this brutal war would represent a recognition that this country can overcome past mistakes, for which many must assume the blame, and would open possibilities for conciliation that continued hostilities and bombing can never provide. We believe full disengagement should be pressed and oppose continuation of the air war for any purpose other than the immediate protection of United States troops in the process of withdrawal.

All of us feel deeply the need for Americans of all ages to find nonviolent, constructive outlets for the expression of their views, their distress, and their concern. We support activities to this end as long as they are not at the expense of the rights of others or at the expense of the continuation of constructive, educational, and other scholarly activities of the universities and colleges.

We therefore support the effort of those who work in behalf of candidates sympathetic to their views or communicate their feelings to appropriate government officials. We do not condone coercive action by individuals or groups seeking to impose their particular convictions or concerns on others.

The Smullin Resolution

The following resolution, offered by Professor Louis D. Smullin, was adopted at a special meeting of the M.I.T. faculty on April 28:

A majority of us at this meeting of the M.I.T. faculty hold that:

1. American military operations in Southeast Asia for many years have been highly destructive of the people and land of Indochina, at great and irredeemable costs to the United States. Two years ago, this Faculty petitioned Congress to "take all steps necessary to bring the war to a quick end." Now it is even clearer to us that further destruction is a tragic waste, and we urgently repeat the call to our government to get out of this war as fast as possible.

2. The prolongation of this terrible war assaults the consciences of hundreds of our students, who now feel once again that they cannot continue business as usual. We ask all our colleagues to respect this feeling, to allow maximum flexibility of academic schedules during the current crisis, and not to penalize students academically for acts of conscience.

"To Show We Are Concerned"

Who were M.I.T.'s "strikers?" Are they all as concerned as their spokesmen about M.I.T.'s "complicity?" Here are the comments of four students selected at random from the (non-obstructive) picket line on Monday morning, April 24:

* * *

Charles O'Neill, a freshman from Washington, D.C., saw the strike as a means of demonstrating to the Institute the resolve of its students. Many, he felt, wanted to take some time off to march on Washington or to canvass for candidate McGovern. But the Institute needed evidence of student sentiment before it would act.

"The strike is not to shut down the university, but to relieve the pressure of grades . . . so that students can do something more important than go to classes." And he believed that most of the other participants in the strike were agreed on that.

Another purpose, he continued, "is to show other students we are concerned about this and to gain support in numbers."

Mr. O'Neill has participated in political activities for the past five years. He has been in campaigns and peace marches in Washington and in the spring of 1970 he took part in a student strike at his high school. He is now active in the McGovern campaign.

* * *

Scott Garren is married and living off-campus; he will graduate this June in humanities and engineering.

To Mr. Garren, the central objective of the strike is "getting the U.S. out of Southeast Asia—and showing political opposition in the U.S. is an effective way of doing it."

A second target, he added, is war research at M.I.T. But the way to attack it is not by direct action, but rather by convincing fellow students and thereby "depriving the war research effort of talented young engineers who will not be willing to participate."

Mr. Garren was ambivalent about cancelling classes. It is "an immediate practical goal," he said, "not a theoretical one . . . but the university should at least respect the students' wishes to strike."

Though he was not then attending classes, he could not stay away long. He said his financial situation made it necessary that he graduate in June, so if the strike continued he would "have to make an agonizing decision."

Should the strike be more militant than that morning's picketing? That would be appropriate, Mr. Garren believed, though perhaps not feasible under the circumstances. But he personally, he replied, as a married man had responsibilities that would make it "very bad to end up in jail."

* * *

A senior who comes from Pakistan and asked that his name not be used said the purpose of the strike is "to bring the attention of the public to what is going on in southeast Asia.

"If there were no strike, the new bombing would go unnoticed by the public," he said. "Should this not be protested immediately and with great vehemence, Nixon will have further opportunity to escalate the war.

"Furthermore, we should demonstrate that this university is not completely in compliance with the military-industrial complex." He would like to see M.I.T. cancel classes as a protest against the bombing, "but I don't feel that that is possible. . .

"At this time, the strike is purely spontaneous—there was some initial organization by S.D.S., but it is not relevant by any means . . . only about five of the 70-odd people here this morning are S.D.S. people, and they are providing no guidance or leadership."

After coming here from Pakistan, he has spoken out against that country's military government. (He intends to go back there at the end of the summer.) "But I think the U.S. has beaten us Pakistanis at our own game, which is making refugees and killing—but the press here is still quiet about what the U.S. is doing in Southeast Asia."

* * *

Another student, a freshman from Long Island, N.Y., also asked that his name not be used. The purpose of the strike, he said, is "to show Nixon there is solidarity among students . . . and to show the Institute we mean business." He wanted a week's moratorium on classes so that students could participate in canvassing and teach-ins. And he shared the view that the Institute was looking for a strong demonstration of determination on the part of the students before it would cancel classes.

"War research is a significant issue," he said, "but we are trying to play it down a little bit to attract more moderate students." He favored not an abrupt end to war research at M.I.T., but rather a policy of replacing contracts as they run out.

He spoke strongly against the participation of S.D.S. in the strike: "S.D.S. is basically a bunch of shitheads. Some of their aims are reasonable, but others are not . . . . They are trying to impose their views on other students, and a lot of people are getting pissed off."

If a moratorium on classes were called, he said, he would go canvassing. Though it was too late for the Massachusetts primary (the next day was election day), "You can always talk to people about peace." Classes or no classes, though, he planned to be canvassing for McGovern on primary day.

Institute Review

Can Science and Medicine Co-habit?

The need for cooperation between physicians and life scientists on the one hand and engineers, mathematicians, and physical scientists on the other has for some time been a lively topic in educational circles (*see* Technology Review *for April, 1970, pp. 24-65).* Now, with the help of two major grants announced this spring, the new Harvard-M.I.T. Program in Health Sciences and Technology has begun several fundamental attacks on the problem.

The program's first major research support came in late March, when the National Heart and Lung Institute awarded a $5-million, five-year grant for a multidisciplinary program of research on biomedical materials. The work initially involves 33 investigators from Harvard and M.I.T. working in 15 separate projects. M.I.T.'s Professor Robert W. Mann is in charge.

Less than two weeks later, the Commonwealth Fund of New York awarded a $600,000, one-year grant to help cover operating expenses of the Health Sciences and Technology Program. Officially instituted by M.I.T. and Harvard in the spring of 1970, the Program was developed with the aid of an earlier grant from the same source.

Research is only a part of the program's activities, explains its director, Professor Irving M. London. Other activities are planned or already going on in education, development of instruments and techniques, and organization and delivery of health services.

Education

Early efforts gave priority to education, and it is here that the most progress has been made. Twenty-five students have already completed the first year in a new program of preclinical medical education at the Harvard Medical School. The aim is to integrate some of the techniques and concerns of the physical sciences into medical education and to let the students take elective subjects at M.I.T. or Harvard. The medical subjects are taught by teams including not only medical professors, but also physical scientists; they are drawn from the faculties of both Harvard and M.I.T.

The Health Sciences and Technology Program also encourages teaching "at the interfaces of human biology with engineering, the physical sciences, and mathematics." More than a score of these subjects—designed primarily for aspiring biomedical engineers—have already been introduced, most of them under the auspices of departments at M.I.T.

Professor London also hopes to develop "curricula in human biology as an integral part of higher education in the life sciences." All too often, he feels, the study of human systems has been isolated in off-campus medical schools and has been inaccessible to other scholars.

"Money . . . Isn't All that Available"

One of the principal figures behind M.I.T.'s expanding interest in the health sciences is President Jerome B. Wiesner; he was leading the planning of the program long before he became President. In a recent interview, he explained some of M.I.T.'s motivations:

"We have a strong Biology Department, a Nutrition Department with a lot of biologists who are naturally interested in applications of their research; . . . and in the engineering school, we have for at least two decades had an interest in applying research to biological problems. . . .

"Then in parallel, we have a growing commitment on the part of the nation for better health care for more people. We realize that many problems cannot be handled by the traditional methods of medical research alone. . . . You need more inputs. . . .

"The School of Management has come slowly to the decision that public systems management was to be as important in the 1970's as private corporation management problems. . . . In the urban field, we have a growing faculty and student interest in health care delivery as a major unsolved problem of the cities.

"Also, we realized that you want some people who are trained as both physicians and engineers . . . So we began exploring ways of developing combined curricula. . . .

"And we are also, at least now, responding to a shift in student interest. . . .

"The availability of money—and it isn't all that available—is not the most important factor. . . . When we began, it didn't appear all that easy to finance. For example, in 1965 we concluded that we couldn't finance a medical school. And I'm not sure we made the right decision; I wasn't sure at the time."

Biomaterials Research

The $5 million biomedical materials research program grew out of a series of seminars held over the past two years under the auspices of the Program in Health Sciences and Technology. The seminars brought together engineers, physical scientists, medical researchers, and clinicians; together, they planned the research program.

"This grass-roots development of the program of research is a crucial element," Professor London said. He sees the genesis of this program as a prototype for future interdisciplinary work.

The biomaterials research projects fall into four categories: non-thrombogenic surfaces (synthetic materials which can remain in contact with flowing blood without altering the blood composition or causing coagulation); dynamic behavior of macro-molecules, membranes, and cells (particularly blood cells); transport of blood and its constituents within the body; and instrumentation and techniques for biomaterials science.

Biomedical engineering has been pursued in numerous forms at M.I.T. for some time. Last September, the Committee on Biomedical Engineering noted that about 150 graduate students and 50 faculty members were already active in these studies. It cited opportunities for graduate work in biomedical engineering in 12 departments and eight laboratories and research centers.

Preclinical Medical Education

The new preclinical medical curriculum represents most immediately a rearrangement of subject matter into synchronization with the academic calendar. Subjects in the normal medical curriculum are taught in short, sequential blocks of time instead of in semesters. The new arrangement not only makes it easier for medical students to take electives in science departments; it also means that for the first time scholars from the universities will be able to take courses in medicine. Some fifteen engineering and science graduate students from M.I.T. and Harvard are accommodated in the human biology classes of the new medical program.

For some, alumni seminar coffee breaks are the best parts of the meeting. Above, Louis D. Smullin, S.M.'39, Head of the Department of Electrical Engineering, visits about technology and the economy in the 1970s with Marvin Chodorow, '39 (right).

After the first two years, students in the new program join their counterparts in the regular Harvard Medical School curriculum for the clinical years of study. They receive the M.D. degree from the Harvard Medical School at the same time as the others. But students will eventually be able to design programs leading to more than one degree; for example, a student might work simultaneously for an M.D. from Harvard Medical School and a Ph.D. from M.I.T.

All the members of the first group had completed their undergraduate work before entering the program. This year, however, a few students will enter at the end of their junior year—and begin work on the M.D. before receiving the S.B.

The new program aims to change not only the order, but also to some extent the content of the preclinical medical curriculum. This is the aspect of the program which is the slowest to develop: The physical scientists who are to help teach the new medical subjects spend the first year in the classroom as students. The second year, they are expected to provide input to the course, and the third year, Dr. London explains, "the course should reflect their input and therefore be unique."

"Give It Five Years"

In the first year, many at the medical school were left wondering what, if anything, had changed. Gus J. Vlahakes, '71, one of the first group of students, said, "The integration of physical sciences doesn't seem as great as advertised; some of it seems non-genuine, like physical analysis for its own sake." But he was quick to add that "the first year is not indicative of what will be done in the future—give it five years."

Mr. Vlahakes is pleased with the new program and feels that most of the other students are, as well. As a group, they are highly motivated but not particularly competitive, he said. And their career goals are not very different from those of the students in the regular curriculum: "We cringe every time a visiting lecturer calls us 'bioengineers.' "

What Will Sell in the Seventies

Two ideas kept appearing during the Alumni Seminar on Technology and the Economy in the 1970's held at M.I.T. this spring: We will spend more for services than for goods before long, and the decisions to be made about development and trade will increasingly involve more of government and society than they do now.

As many people will be employed in health and education in 1985 as in the production of commodities, J. Herbert Hollomon, '40, Consultant to the President and Provost at M.I.T., told the seminar group. Government will employ another equal share. Presently, the service industries employ less than one-half as many as the producing industries.

This is one change we are already dealing with, he said. But there is another change of which we are only now becoming aware. In the 1950's and early 1960's, the federal government purchased much more research and development than scientific and engineering organizations could supply. The price went up for talent and engineers were created by decree as well as by degree. We have now the well-known surplus, as federal spending for research and development was declined. The rate of increase of our industrial productivity is also falling. Productivity increased by 2.9 percent per year in the early sixties, but by only 1.8 per cent per year in the latter sixties. The declines in productivity and in development funding, he added, mean that we are less able to compete for world trade—even in high technology items. Now, 90 percent of the motorcycles sold here are built abroad, as are 75 percent of the black and white television sets.

Federal research funding—redirected from military and space objectives—could help keep us technically competitive, agreed Paul MacAvoy, Professor of Economics and Management at M.I.T. One strategy has government providing initiative for competition within our borders in industries that are essentially monopolies. The New York State legislature, for example, once thought of building a railroad to compete with the Erie.

Funding from government in addition to funding from industry might mean that the United States could develop several competing technologies to see which was best, rather than being able to afford only one. For example, Dr. MacAvoy said, we could develop either a gas or liquid breeder reactor for, say, $3.5 billion. But with extra monies which government might supply we could (for $4.5 billion) develop both until we could choose intelligently between them.

Government partnership might be necessary simply because industry may have trouble raising funds of this magnitude, he added.

But perhaps not, said Frank Davidson, Lecturer in Mechanical Engineering. He recalled that a recent Imperial Chemical Industries stock issue of several billions was oversubscribed on the order of 20 times on the London exchange. Technical capital can be had privately, he said. Perhaps the government's role is not that of capitalist but of catalyst protecting the public interest and creating conditions for private enterprise. The first person needed in a new technical project, Mr. Davidson (who has a degree in law) said, is a lawyer, not an engineer.

And that is right, said Louis D. Smullin, S.M.'39, Head of the Electrical Engineering Department. He described the relatively new Health Planning Council of Greater Boston—formed as federal and state law demanded—which must approve any medical building or alteration that costs over $100,000. In the use of resources and in the control of pollution, he added, there must be massive intervention by government.

A number of discussions on individual industries followed the morning panel:

☐ Irwin W. Sizer, Professor of Biochemistry, noted that in 1960 the U.S. spent $12 billion on health, in 1972 we will spend $72 billion, and in 1980, $180 billion. That will approach 12 per cent of our G.N.P.—as much as he believes we will ever devote to health care. Yet the U.S. remains 25th in the world in the quality of our health care. We have some choices to make: How many kidney machines will we publicly support, and how many roads?

☐ Health care industry spending has not yet reached its peak, agreed Jack McConnell, of Johnson and Johnson. For example, the health care industry now badly needs a copier for x-rays, and a cheap, quick, easy test for malaria.

☐ Ira Dyer, Head of M.I.T.'s Department of Ocean Engineering, listed with "conscious caution" several ocean-related fields as economic opportunities of the 1970's: fuel and mineral winning, defense, and marine and shoreline environmental protection.

☐ Housing is still a curious business, William A. Litle, Sc.D.'63, Associate Professor of Civil Engineering, said. The new concepts of the next decade will be not in technology but in management. Will industrialized building make homes cheaper? No certain answer. But one In-

Mrs. William H. Bates, the widow of the late Congressman for whom M.I.T.'s new linear accelerator is named, was the guest of honor at its dedication this spring. In the photograph (right), she views a portrait of Mr. Bates with President Jerome B. Wiesner (left) and Howard W. Johnson, Chairman of the Corporation.

dustrialized home has found respectability, he said: The reason so many new units of housing appear in government statistics for 1971 is that mobile homes were counted for the first time.

In a discussion the following day of the economic context, Dr. Irving Plotkin, '68, Senior Economist at Arthur D. Little, Inc., described a method for quantifying the risk involved in an industry by calculating the variance in return on investment among individual companies in the industry and comparing it with return on investment for the industry as a whole. By calculating risk and return for many different industries, he has found that the two vary together. He described also an analysis of the insurance industry's economics. Insurance companies are traditionally reluctant to give out complete information on their finances—one presumes because their investment return on prepayment of premia more than compensates for their net underwriting loss and yields excessive profits. Not so: Dr. Plotkin found, after untangling the companies' unusual accounting methods, that the industry was realizing an unusually low return on invested capital. "That is the skeleton they were so carefully hiding," he said.

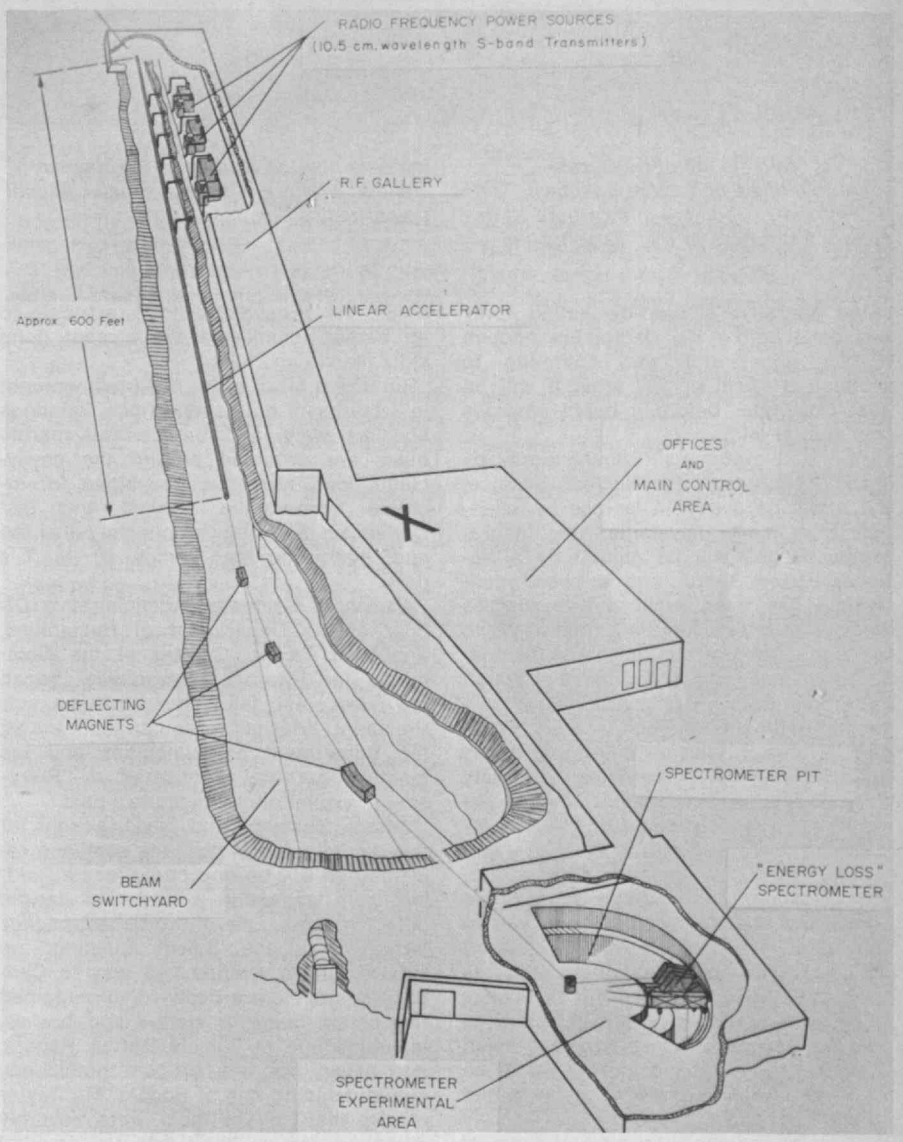
The Bates Linear Accelerator: New Nuclear Research Facility

With half a day of congratulations and thanks, M.I.T. formally dedicated its new 400-Mev. linear accelerator last April. It named the facility, located in Middleton, Mass., in honor of the late William H. Bates, U.S. Congressman from the district containing Middleton and member of the Joint Committee on Atomic Energy.

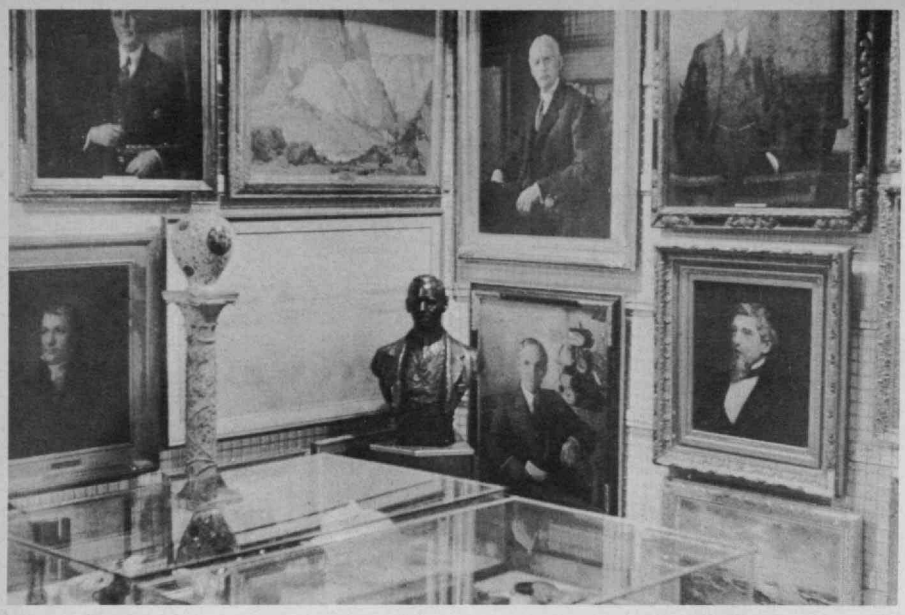
The new accelerator falls into what might be considered an "intermediate-energy" category. Its principal use will be for scattering electrons from whole nuclei and its outstanding characteristics will be high beam intensity, precise control of the beam, and high duty factor. The full-power beam will have a cross-section diameter of only about a millimeter. The accelerator will deliver the beam in pulses of duration up to about 15 microseconds; at slightly reduced power, it will deliver up to 5,000 pulses a second. The only comparable machine in existence is the French Atomic Energy Commission's new 500-Mev. accelerator in Saclay.

M.I.T.'s new $7 million machine is built on a 77-acre hilltop plot in what was formerly the grounds of the Essex County Sanitorium. Its layout is shown in the diagram on this page.

Only part of the machine is now working; laboratory workers have begun at the low-power end and are making the ma-



M.I.T.'s new Bates Accelerator proper is in an underground vault some 600 feet long. At one end is the electron injector and at the other is the "beam switchyard" and experimental area. Directly above the accelerator vault, at ground level, is the "R-F gallery," where a series of five giant microwave transmitter assemblies are housed. Carefully-synchronized microwave power is piped through the floor in waveguides to "resonant cavities" in the accelerator where the microwave power provides a "kick" for the accelerating electrons. Large magnets in the "switchyard" will focus and deflect the beam to the proper spot in the experimental area. At the far end is a large high-ceilinged room dominated by a wide, deep semicircular trench in the floor. Electrons scattered from the target will be deflected down into the trench where they will enter a 200-ton spectrometer which rides around the semicircle on rails. The spectrometer will have a resolution of one part in 10,000.



M.I.T.'s "attic" is full of treasures—some identified and some unknown. The best of the collection—shown here in its curator's quarters in the "Epsco Building"—is now on display in the Hayden Gallery, where it will be a special Alumni Day attraction.

chine operative section-by-section. Only two days before the dedication enough of the accelerator was operating to produce a beam of 107 Mev. It will be next December before a beam emerges from the far end.

The accelerator is administered by M.I.T.'s Laboratory for Nuclear Science, but it will be available for use by scientists from many universities and laboratories. Its use will be guided by a National Policy Board, and a users' conference has been organized to discuss and set priorities for the experiments to be conducted. Most of the funds for construction and operation came through the Atomic Energy Commission.

In his dedication speech, M.I.T.'s President Jerome B. Wiesner noted that this is the first time M.I.T. has named a facility for a legislator. "Legislators who understand the role of science in national affairs are a rare asset," he said, "and Congressman Bates was one of those."

Dr. Wiesner also used the occasion to draw encouragement from recent government announcements concerning support for basic research. The United States is no longer the only nation which invests in basic research as an aid to achieving national goals; so, he said, "we are left with the uneasy feeling that we might be losing ground in subtle ways in fields that hold the key to the future.

"It is encouraging after several years of skepticism and hesitation to see the national government reaffirming its commitment to basic research. . . . Modern experience has shown that basic research is the most important supplier of new technology."

Cleaning The Attic

Long dusty hallways, stacks of old furniture and laboratory apparatus, and costumes from plays and Tech Shows of years ago mark Building N52—popularly called the "Epsco Building" in tribute to an earlier tenant—as the closest thing M.I.T. has to an "attic."

But now a bit of order has been wrought in a corner of the second floor. Paintings line the walls and bronze and marble busts are arranged around the newly-clean floor. Here the Committee for Institute Memorabilia, formed only last Christmas, has begun collecting the old and nearly-forgotten relics of M.I.T.'s past.

Warren A. Seamans, Administrative Officer of the Department of Humanities, and Walt Taylor, Curator of the Committee for Institute Memorabilia, began the work last fall. The occasion was President Wiesner's inauguration—when the Department of Humanities and the Institute Archives sponsored a "Retrospect" exhibit on the Institute's past.

Messrs. Seamans and Taylor sought for this exhibit several portraits someone remembered but no one could locate; finding them was often a matter of careful detective work. One of the richest caches turned up in the "Epsco Building" on Massachusetts Avenue half way to Central Square. Here a dusty room contained five or six busts in marble and bronze, including one of William Barton Rogers, and seven portraits of past presidents, again including one of Rogers. Mr. Taylor recalls that "all of them were severely damaged and so filthy that you couldn't even tell who they were."

Many of the relics are the work of distinguished artists; others are of interest to historians of art. Already a scholar has used the collection for his research.

Portraits have been found of all the past presidents of M.I.T. save Ernest F. Nichols, whose tenure was limited to nine months, and Howard W. Johnson, whose portrait will be painted soon. The old paintings have now all been cleaned in preparation for a show currently in progress in the Hayden Gallery.

The Committee on Memorabilia's work has been financed entirely with special gifts. Mr. Taylor says that if more funds can be found, he would like to see "a permanent historical museum to house these things." He proposes a special, permanent exhibition room.

Law at M.I.T.: Unlikely but Inevitable

Three recent grants for curriculum development and summer student projects are helping M.I.T. develop what is for it a novel interest: law.

Though M.I.T.'s involvement in law may seem improbable, the faculty member who is most directly involved in opening the subject believes that it is both logical and inevitable. Professor Michael S. Baram of the Civil Engineering Department, an attorney, explains it this way: "Academic departments are now grappling with complex societal problems, using systematic and interdisciplinary approaches, which increasingly include legal, regulatory and public policy considerations. Law also provides an important educational input for scientists and engineers by raising issues of professional and peer group responsibility."

And for their part, graduate and undergraduate students are interested not only in interdisciplinary research but also in law as an instrument for social change and in the legal profession itself. This year about one-tenth of the freshman class expressed interest in law as a career, and about 60 seniors applied to law schools.

Two of M.I.T.'s new grants, from the Environmental Protection Agency and the National Endowment for the Humanities, are for development of two interdisciplinary subjects which Professor Baram teaches. They are "Legal Aspects of Environmental Quality" and "Law and the Social Control of Science and Technology." Each subject involves the synthesis of legal, social, and technical perspectives and knowledge to model social problems and control options. They represent an integrated approach to problems normally subjected to fragmented social analyses, Professor Baram says. Even the enrollment is interdisciplinary, including students from engineering, urban planning, social science, law, and public health.

The third grant, from the National Science Foundation, is for a program of summer field work for undergraduates. The participants will work in law firms, courts, agencies, law reform programs, and legal aid societies as part of a structured field work/classroom experience.

The summer program is now being developed by the Undergraduate Law Association, headed by Neil B. Cohen, '74, with assistance from Professor Baram (as faculty advisor) and several members of the Department of Urban Planning.

In addition, Professor Baram is cooperating with Professor Jerrold Zacharias, Boston attorney Philip Mason, and the Harvard Law School's Dr. Myra Karstadt to teach a course in law for M.I.T. students. The course uses films of the police in action and legal materials on crime and civil liberties.

Mike Martin, '72, works on the Wankel engine which will power M.I.T.'s entry in this summer's Urban Vehicle Design Competition for engineering students. The engine will burn LP gas and will have modified ignition and exhaust systems. The car it powers will incorporate several advanced safety systems.

Wankel-Powered Aquilifer

For the third time in six seasons, M.I.T. undergraduates are at work building a low-pollution automobile for a national competition. But this time—in contrast to earlier efforts—their entry will exploit conventional instead of unconventional technology.

Perhaps this is creditable to experience: M.I.T.'s entry in the 1972 Urban Vehicle Design competition will be built by a team of some ten students, headed by Dietrich R. Herrmann, '72; he and three others are veterans of 1970's Clean Air Car Race, a student competition to build low-pollution automobiles and prove them on a transcontinental rally *(see* Technology Review *for January, 1971, pp. 20-29)*. This year's U.V.D.C. challenges engineering students to design and build the car best suited for urban use *(see "Trend of Affairs," p. 68)*. Final testing of the entries will take place near Detroit this August.

With funds furnished by M.I.T., the students recently purchased a Mazda R-100, a Japanese production automobile with a 60-cubic-inch Wankel engine. Michael K. Martin, '72, (who was in charge of the emissions testing program for the Clean Air Car Race) explains the choice of a Wankel engine: It is physically small for the power it produces, it can be run with a slightly leaner mixture (for reduced emission of unburned hydrocarbons) because it has more gas turbulence in the combustion chamber and thus improved flame propagation, "and we just like it because it's different."

But the car M.I.T. enters in the competition will bear little resemblance to the one the team bought. They plan the following modifications:

☐ The fuel system will be converted to supply LP gas instead of gasoline. Thus the engine will run on a still leaner mixture for further reduction of hydrocarbon emissions. In particular, there will be no need to provide an unusually rich mixture when starting the engine because the fuel is supplied as a gas.

☐ Non-combustible gasses from the exhaust will be recirculated to dilute the combustible mixture in the chamber. Thus the combustion temperature will be lowered to impede the formation of oxides of nitrogen.

☐ The exhaust will go through a thermal reactor where carbon monoxide and unburned hydrocarbons will be oxidized before they are released.

☐ The ignition system will be replaced with a breakerless electronic system. The latter will allow more precise control of the timing so that the formation of oxides of nitrogen can be reduced; and it will cut down on misfires, a significant cause of unburned hydrocarbon emissions and a potential safety hazard when using a thermal reactor.

☐ Depending on how well the preceding systems work, it may or may not be necessary to add catalytic reactors downstream of the thermal reactor to supplement its function.

After all the power plant modifications, Mr. Martin expects that the car should have about 80 horsepower and should perform "about like a standard Toyota."

Safety modifications will include reinforced side beams in the doors, special bumpers front and rear with shock absorbing mechanisms for crashes, a roll cage for the passenger compartment, interior padding, bucket seats with shoulder-type safety harnesses with inertia-reels, a periscope for rear vision conforming to 1976 federal standards, and a "drunk alert" to prevent an intoxicated driver from starting the engine.

A Debussy Premiere at the M.I.T. Symphony

"It is not every day that you can hear the world premiere of something by Debussy," music critic Michael Steinberg wrote in the *Boston Globe.* Nor would anyone expect it to happen at M.I.T. But it happened early this spring, when the M.I.T. Symphony played a program which included the first performance of the first movement of an unfinished Debussy symphony.

Mr. Steinberg, who called it "a fresh moment in our concert life," explained to his readers that "in 1880 Debussy, just turned 18, began a four-movement symphony. He only got as far as a piano four-hand version of the first movement. . . . The manuscript turned up in Russia in 1930 and was published there. A few years ago American composer Mark De Voto, who now teaches at the University of New Hampshire, orchestrated it, and Saturday (March 18, 1972) we had the first performance.

"Under the knowing, enlivening, and musically intelligent leadership of Robert Freeman," Mr. Steinberg wrote, "[the M.I.T. Symphony Orchestra] sounded very listenable, and in a very demanding program, too. . . . I noted that at $1 a head, this nonprofessional orchestra, without benefit of big or even a-little-bit-big names, packed a hall with 1,200-plus seats."

International Tiddlywinks

If ping pong can be a vehicle for international rapprochement, why not tiddlywinks?

Home in April after a one-week tour of England which included winning the world championship from Southampton University, M.I.T.'s eight-man tiddlywinks team found themselves richer by 11 pounds—their honorarium for a brief appearance on British television; they'll use it to buy a team trophy—the first World Tiddlywinks Championship Cup.

M.I.T. won both rounds of the championship match in Southampton on March 28 and 29, 65-47 and 58-54. But Timothy D. Schiller, '72, said on returning that the Southampton team was actually more skilled at the game than the M.I.T. players. The decisive difference was strategy, he told *Tech Talk*: M.I.T. was more "cautious," and it paid off.

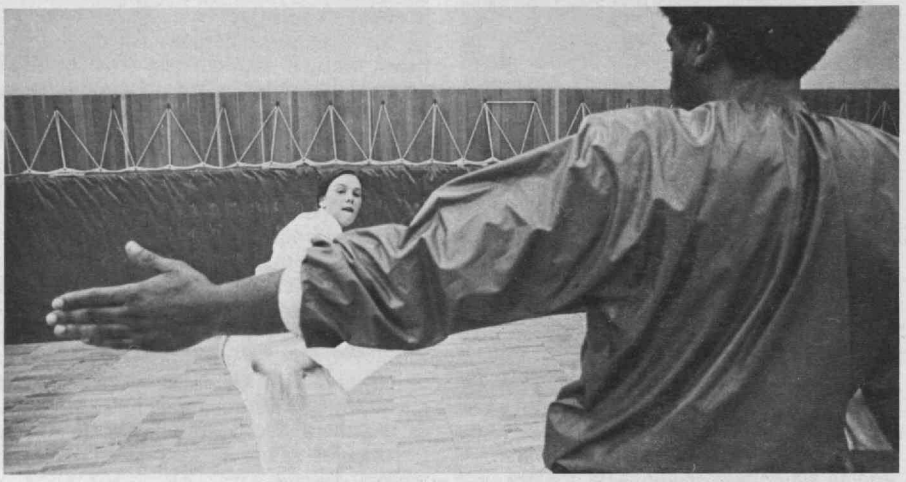
Six of M.I.T.'s eight World Tiddlywinks Champions pose at Logan Airport holding the squidgers they used in their spring-vacation matches at Southampton University: front—J. Franz Christ, '73, Timothy D. Schiller (captain), '72, and Craig A. Schweinhart, '73; back—David H. Lockwood, '74, William H. Renke, '73, and James R. Marlin, '73. Returning on another flight—and so not in the picture—were Michael S. Schwartz, '72, and W. Peter Copper, '75.

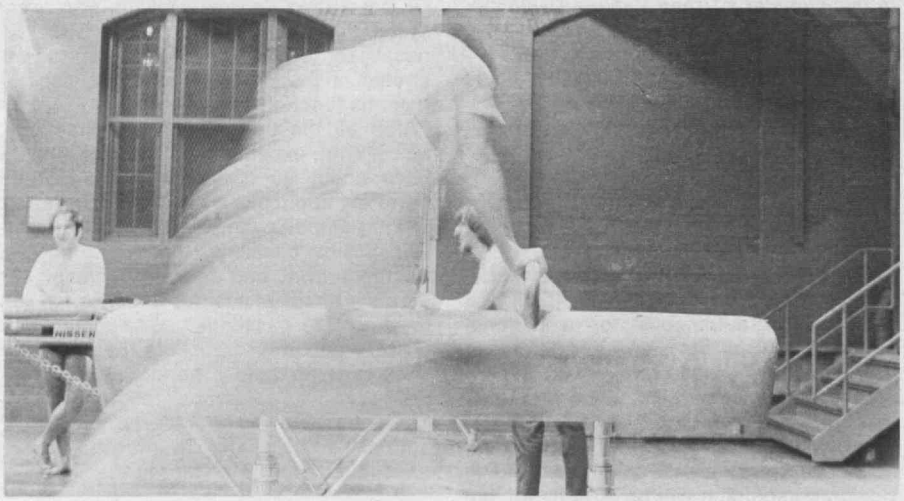
18 Hours with M.I.T. Athletics

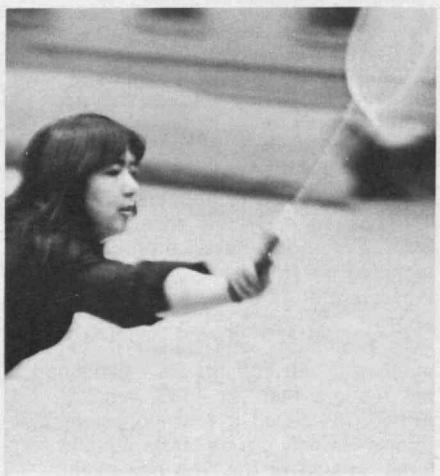
Photographs by
Owen D. Franken, '68

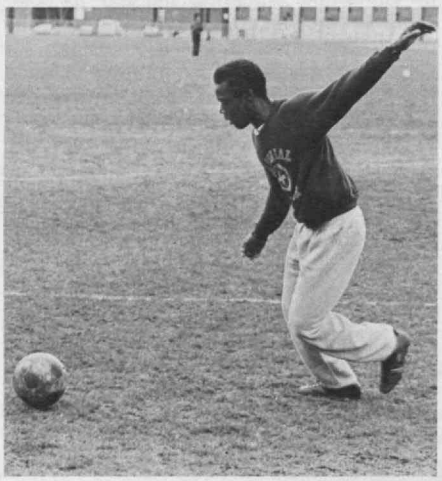
Technology Review this spring asked photographer Owen D. Franken, '68, to record as much as he could of the way athletics take place at M.I.T. during one typical 24-hour period—Thursday, April 13. It was a clear, cool day—perfect for both indoor and outdoor events.

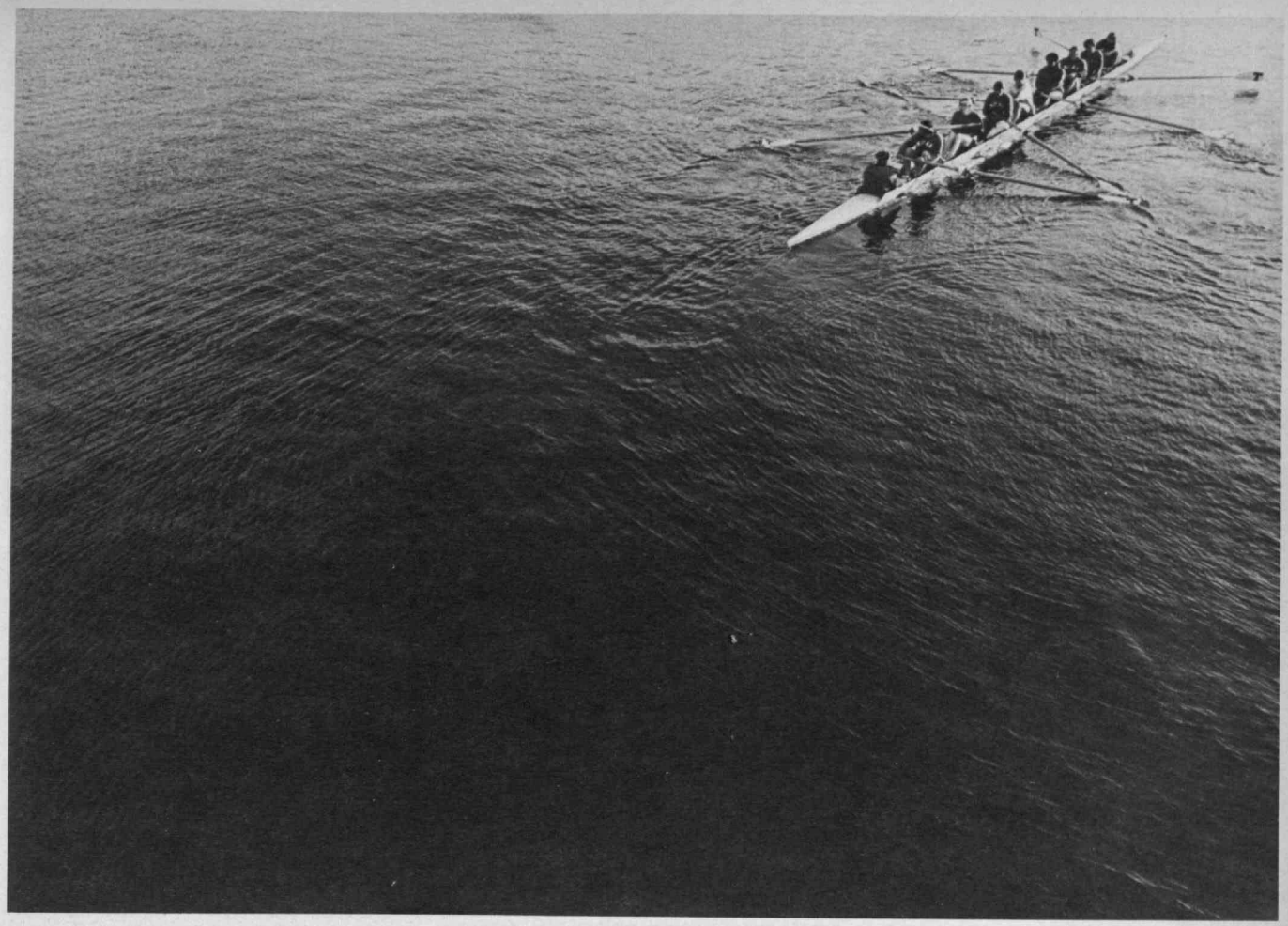
Mr. Franken's encounters began at 6 a.m. when he and M.I.T.'s co-ed crew reported to the Pierce Boathouse, with results made obvious by the photograph at the lower right, opposite. From then until evening it was a busy day: the pictures on these pages and the one following record karate, softball, badminton, soccer, archery, calisthenics, swimming, jogging, tennis, gymnastics, modern dance, and track. The day ended at 8 p.m. as the varsity heavyweight crew returned from its Charles River workout.

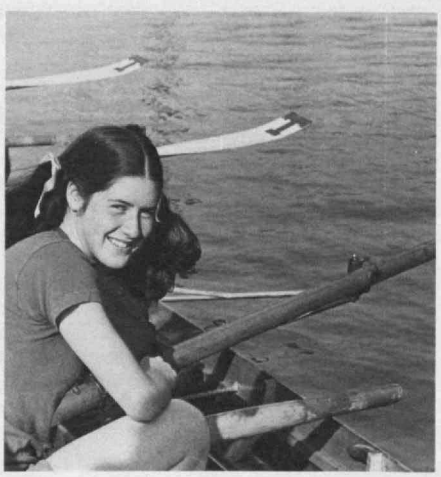


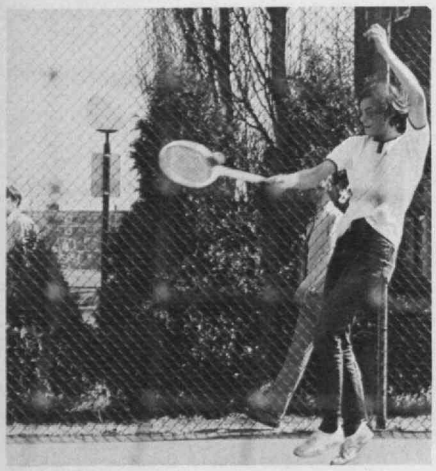










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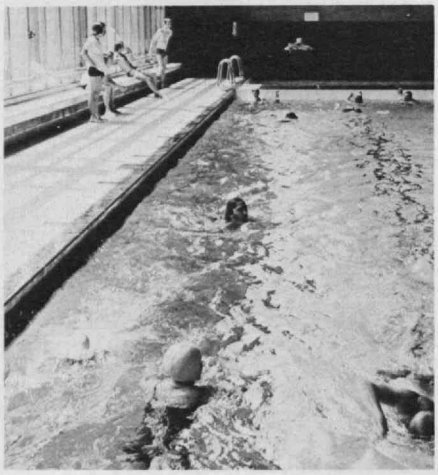


Representatives of Digital Equipment Corp. and the M.I.T. Department of Electrical Engineering sign the contract under which Digital joined the expanding group of companies and laboratories offering co-op training to electrical engineering M.I.T. students. Seated: Winston R. Hindle, Jr., S.M.'54, Digital's Group Vice President for Personnel and Product Lines; Kenneth H. Olson, '50, President of Digital Equipment Corp.; and John A. Tucker, Director of Course VI-A at M.I.T. Standing: Louis D. Smullin, S.M.'39, Head of the Department of Electrical Engineering; Robert M. Fano, Associate Head of the Department for Computer Science and Engineering; Francis F. Lee, '50, Professor of Electrical Engineering; and James J. Fleming of the Digital's Personnel Office.

Expanding the Co-ops

A major expansion in the opportunities open to M.I.T. electrical engineering students through the cooperative program (familiar in M.I.T.-ese as Course VI-A) and a growing interest among students in the work-study opportunities it presents have been reported by John A. Tucker, the Department of Electrical Engineering's Executive Officer for Student Affairs.

Three new organizations, to which M.I.T. students may be assigned for two or three terms of learning-while-earning, have joined the program:

☐ Digital Equipment Corp., Maynard, Mass.

☐ Massachusetts General Hospital, Boston, where students will work in the Medical Engineering Laboratory.

☐ Naval Underwater Systems Center, New London, Conn.

In addition, two companies already associated in the program have broadened the opportunities open to M.I.T. students:

☐ General Electric Co. (the charter member of the program, dating back to 1917) has added its Transportation Systems Division, Erie, Pa.

☐ Hewlett-Packard Co. has added its Electronics Research and Physical Electronics Laboratories in Palo Alto, Calif.

Mr. Tucker said the expansion responds to increasing demand from students for co-op experience in many different fields. This year, he said, 41 per cent of eligible sophomores in electrical engineering applied for Course VI-A—effective at the start of their junior year—compared with only 30 per cent last year. Some 82 Course VI-A students seek co-op positions beginning in June of this year, but only half that number of openings are likely to be available, he said.

Social Service Access Study

How to improve access by public transportation to various social services in Lynn, Mass., as has been the subject of research this spring for the Lynn Model Cities Agency by a student-faculty team from M.I.T. Data from East Lynn social service centers, passenger trip data from public transportation carriers, and field interviews with social service users were obtained and are now being correlated.

Professor Nigel Wilson of the Transportation Division of the M.I.T. Department of Civil Engineering explained the project this way: "Good public transportation is essential if people are to derive full benefit from social services. All too frequently inadequate bus service and expensive taxi rates combine to deny such services to those who need them most."

The purpose of the M.I.T. project, he said, would be to discover "major unmet needs" (if any) and to provide Lynn city officials with "data and experience they need to implement new transport services."

Leading in Chemical Engineering

A new study of distinguished chemical engineers reports that more have come from M.I.T. than from any other U.S. educational institution.

B. R. Siebring and M. E. Schaff of the University of Wisconsin identified 198 chemical engineers as "eminent" by scanning membership lists of the National Academies of Science and of Engineering, winners of chemical engineering awards, and such biographical directories as McGraw Hill's *Modern Men of Science.* Nineteen of them turned out to hold doctorates from M.I.T., and 13 of them held undergraduate degrees from the Institute.

M.I.T. led among the doctorates, followed by the Universities of Michigan (17) and Wisconsin (12); the Institute was second in the baccalaureates, led by the University of Illinois (14) and followed closely by the University of Michigan (12).

Another statistic: M.I.T. led by far in the number of its baccalaureate graduates between 1965 and 1970 who continued with graduate study to receive doctorates at some U.S. university—77 compared with runner-up Cooper Union's 52.

Professors Siebring and Schaff reported their results in the American Chemical Society's journal *Chemical Technology* (January, 1972).

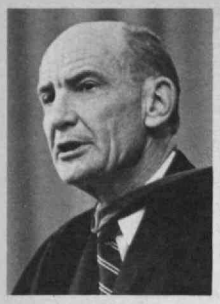
Professional Education

Donald A. Schon, an urban planner who has made important contributions to understanding how social and technological changes affect society as Director of the Organization for Social and Technological Innovation, has become Ford Professor in the M.I.T. Department of Urban Studies and Planning.

William L. Porter, Dean of the School of Architecture and Planning, says Dr. Schon will extend his activities into educational planning for professional work in urban affairs.

Dr. Schon studied at Yale, Harvard, and the Sorbonne (in Paris) and was associated with the National Bureau of Standards and Arthur D. Little, Inc., before the formation of O.S.T.I.; he has been Visiting Professor at M.I.T. since 1968.

Mrs. Paul M. Chalmers (with President Jerome B. Wiesner, above) returned to M.I.T. this spring for the dedication of the Paul M. Chalmers Lounge for international students in Walker Memorial; the late Professor Chalmers was Adviser to Foreign Students from 1944 until his retirement in 1966. The lounge houses a library of foreign periodicals, including an extensive collection of Chinese magazines, and in an adjacent office is a short-wave radio on which foreign students may hear programs from throughout the world.



E. E. Morison

Elting E. Morison Returning as Killian Professor in Humanities

One of America's distinguished modern historians—Elting E. Morison, Master of Timothy Dwight College, Professor of History, and Director of the Scholars of the House Program at Yale University—will return to M.I.T. on July 1 to become Elizabeth and James Killian 1926 Professor in the School of Humanities and Social Science.

Professor Morison is a familiar figure at M.I.T. He was a member of the faculty for 20 years, in the Department of Humanities and later in the Sloan School of Management, before going to Yale in 1967; and he was a member of the review panel on M.I.T.'s "special" defense laboratories in 1969. During his earlier tenure at M.I.T. Dr. Morison edited *The Letters of Theodore Roosevelt* as Director of the Theodore Roosevelt Research Project and a series of papers on U.S. international history, *The American Style.* He also completed a biography of Henry L. Stimson, *Turmoil and Tradition,* and wrote *Men, Machines, and Modern Times.* The last two books received, respectively, the Parkman Prize of the Society of American Historians and the McKinsey Award of the Academy of Management. Earlier he had written *Admiral Sims and the Modern American Navy,* which gained the Dunning Prize of the American Historical Association.

Professor Morison's new chair at M.I.T. was established in 1966 by Dr. Killian's classmates under the leadership of I. Austin Kelly, III. Dr. Morison will be its first permanent occupant. In announcing the appointment, Jerome B. Wiesner, President of M.I.T., recalled the statement of Howard W. Johnson who, as Dean of the Sloan School of Management, named Professor Morison to that faculty in 1953: ". . . an eloquent spokesman for the use of history as a guide to present attitudes and thought."

Pierre F. Lavedin, 1899-1972

Pierre F. Lavedin, '20, a member of the M.I.T. Corporation from 1950 to 1955, died on March 18 at Cape Cod Hospital, Harwich. He had lived in Harwich since his recent retirement as President and Chairman of the Board of Liquid Carbonic Corp., which he first joined as a chemist shortly after graduating from the Institute.

Active in alumni affairs, Mr. Lavedin was President of the M.I.T. Club of Chicago in 1947-48, and he was Estate Secretary for his Class at the time of his death. As a member of the Corporation, he had been a member of the Visiting Committees of the Chemistry and Chemical Engineering Departments and of the Libraries.

Individuals Noteworthy

Warren K. Lewis, '05, Professor Emeritus in Chemical Engineering, M.I.T., to Fellow of American Institute of Chemical Engineers . . . to **Edwin R. Gilliland,** '33, the 1971 Founders Award of A.I.Ch.E. . . . to **Seiya Uyeda,** Visiting Professor, M.I.T. Department of Earth and Planetary Science, the Alexander Agassiz Medal, National Academy of Sciences . . . to Guggenheim Fellows: **Elliott Lieb,** '53, M.I.T. Professor of Applied Mathematics, Statistical Mechanics; **Alan V. Oppenheim,** '59, M.I.T. Professor of Electrical Engineering; **Jeffrey I. Steinfeld,** '62, M.I.T. Professor of Chemistry . . . **James H. Williams, Jr.,** '67, and **Arthur P. L. Turner,** Assistant Professors, M.I.T. Department of Mechanical Engineering, a joint 1972 duPont Young Faculty Grant . . . **Eugene Goodheart,** M.I.T. Professor of Literature, to

Richard D. Robinson, Ph.D.'63 (right), Senior Lecturer in the Sloan School of Management, is honored by the Department of Commerce for his M.I.T. courses in international management problems which have now been adopted in the Bureau of International Commerce Export Expansion Program. The presentation was by Frank O'Connor, Deputy Director of Commerce's Office of Business Services in Boston.

The M.I.T. Club of Oklahoma played host to Mr. and Mrs. Howard Johnson at an April dinner meeting in Oklahoma City. Among those present were Breene Kerr, '51, currently a Member of the Corporation and President-Elect of the Alumni Association and W. R. Holway, '15, honored in 1957 as "Mr. M.I.T. of Oklahoma." Bill Sherry, '21, (above, center) co-holder of that title and former Member of the Corporation is shown with Mr. Johnson (left) and Robert L. Rorschach, '43, (right) President of the M.I.T. Club of Oklahoma. After a few informal remarks to the alumni and their ladies, Mr. Johnson submitted to a lengthy question-and-answer session about Institute affairs. Inquiries ranging from financial matters to student unrest were answered with candor and aplomb. Mr. Johnson was then presented with a suitably-inscribed statuette, a bronze model of Fraser's famous Indian, "The End of the Trail", the original of which rests in Oklahoma City's National Cowboy Hall of Fame.

San Franciscans may take their Bay for granted, but at this outing of the M.I.T. Club of Northern California participants were afforded an opportunity to examine some of the problems—present and future—of the San Francisco Bay Area. The program, organized by the Club's Vice President and Assistant Vice President, Philip L. Molten, '55, and William P. Mott, 3rd, '60, featured a tour of the Bay model (above) presented by the staff of the U.S. Army Corps of Engineers in Sausalito, followed by a one and one-half hour cruise around the Bay (left). (Photos: Philip L. Molten)

present two Christian Gauss Seminars in Criticism at Princeton University, and **Alvin Kibel,** M.I.T. Professor of Literature, named a Fellow of Advanced Center for Humanities at Wesleyan University . . . **Stanley Backer,** '41, M.I.T. Professor of Mechanical Engineering, to Honorary Member, American Society for Testing Materials . . . **Ira Dyer,** '49, Head, Department of Ocean Engineering, M.I.T., to officer, Acoustical Society of America . . . M.I.T. Faculty and Alumni to National Academy of Sciences: **Noam Avram Chomsky,** Professor of Modern Languages and Linguistics; **Willem van Rensselaer Malkus,** Professor of Applied Mathematics; **Hans Lukas Teuber,** Professor of Psychology and Head of Department: **George William Whitehead,** Professor of Mathematics; **Robert Duncan Luce,** '45, Member, Institute for Advanced Study (psychophysics); **George Brooks Field,** '51, Professor of Astronomy, University of California, Berkeley.

University appointments: **Harry Shwachman,** '32, to Professor of Pediatrics and **S. James Adelstein,** '48, to Professor of Radiology, both of Harvard Medical School . . . **Graham B. Wallis,** S.M.'59, to Full Professor, Engineering Sciences, Dartmouth College . . . **John C. Lindenlaub,** '55, to Professor, Electrical Engineering, Purdue University . . . **Edward J. Kane,** Ph.D.'60, Professor of Economics, Boston College, to Everett D. Reese Chair of Banking and Monetary Economics, Ohio State.

Corporate appointments: **Russell P. Westerhoff,** '27, former President, Ford, Bacon & Davis, Inc., to Chairman of Board of Directors . . . **Carleton B. Scott,** Ph.D.'52, to Director, Environmental Sciences, Union Oil Co., of California . . . **John N. Maguire,** S.M.'60, to President, Software A.G. (North America) . . . **John B. Carnahan,** S.M.'61, to Corporate Vice President-Distribution, Borden, Inc. . . . **John K. Castle,** '63, to Executive Vice President, Donaldson, Lufkin & Jenrette . . . **Howard A. Leibowitz,** '63, to Production Superintendent, Advanced Products Plant, Corning Glass Works . . . **Howard W. Johnson,** Chairman of Corporation, M.I.T., to Director, Federated Department Stores Inc.

Deceased

Walter Page, '98, February 15, 1972
Herbert M. Morley, '03, November 25, 1971
John W. Shaw, '04, February 13, 1972
James L. Wick, Jr., '06, March 16, 1972
Arthur O. Christensen, '07, April 26, 1972*
Herbert W. Day, '07, November 13, 1971*
F. Brewster Hooker, '10, April 17, 1971
Archibald M. Eicher, '12, February 24, 1972
James W. Anderson, '17, January 29, 1972
Franklin C. Dexter, '17, March 20, 1972
Walter A. Wood, '17, January 27, 1972*
Benjamin D. Ballantine, '18, March 25, 1972
Samuel Rubin, '18, October 16, 1971
Roy M. Simpson, '18, April 16, 1972

Robert H. Wells, '18, December 22, 1972
Richard A. Wilkins, '18, April 19, 1972
Albert E. Bachmann, '21, August 13, 1971
Raymond C. Fisher, '21, August 13, 1971
William R. Hainsworth, '21, December 4, 1971
G. Howard Le Fevre, '21, April 17, 1972
Joseph C. Morrell, '21, January 11, 1972
J. Russell Hemeon, '22, September 17, 1971
C. William Perkins, '22, August 26, 1971
Herbert W. Smith, '22, April 5, 1972
Frank H. Wood, '22, February 21, 1972
Edward W. Smith, '23, March 7, 1972
Vincent K. Cates, '24, March 14, 1972
Witter T. Cook, '24, March 25, 1972
Morris Cohon, '25, July 26, 1971
Tsok C. Tse, '25, n.d.
Ronnoc H. Connor, '27, January 5, 1972
Kenneth Earl, '30, July 26, 1971
Benjamin F. Clark, Jr., '31, July 15, 1968
James W. Perry, '31, December 24, 1971
W. Otto Bussenius, '32, July 15, 1971
Nathan Paris, '32, January 9, 1972
William A. Shaw, '32, October 13, 1970
Sidney Cornell, '36, January 23, 1972
Sidney M. Bordett, '37, November 1966
Alex M. Hutchison, '37, January 18, 1972
Frank A. Grillo, '40, February 3, 1972
James J. Rattray, '48, April 30, 1972
Louis D. Black, Jr., '43, March 3, 1972
Philip J. Friedlander, '48, January 4, 1972
Joseph A. Sabo, '52, February 6, 1972
Asghar Ali, '56, April 8, 1972
Richard H. Thompson, '56, October 24, 1971
Jacob P. Didier, '65, December 14, 1971
Sharad K. Pathak, '68, August 29, 1970
*Further information in Class Review

Class Review

95

I telephoned Tyrrell Cheney, '03, and learned that he had been having a "bout" with arthritis but was somewhat better. Hope he is much better when he reads this.

Summer is almost here and my good wishes to all for a happy season.—**Andrew D. Fuller,** Secretary, 1284 Beacon St., Brookline, Mass. 02146

96

Recently I was in Phoenix and visited Litchfield Park, named for **Paul W. Litchfield,** '96. During World War I, Goodyear needed a place to grow long staple cotton used for tires and Arizona was studied. The chairman of the board, Mr. Litchfield, found that the climate of Phoenix was advantageous for both cotton and people (in the wintertime). He designed a large hotel with surrounding cottages as a recreation center for Goodyear executives. News of the Wigwam spread and by 1929 it was decided to yield to popular demand and convert it to a public resort. Many restrictions went with it, one of which was a "no liquor" policy. The compromise which was reached provided a non-denominational church in return for a bar. Both are still in operation!

Another restriction prohibits the cutting of any existing trees or shrubs. This resulted in laying out streets with natural curves—a real pleasure to behold after traversing 100 blocks of grid-iron streets of the city. This delightful spot just beyond the urban sprawl of Phoenix is a real memorial to the far-sightedness of Paul Litchfield.—**Clare Driscoll,** Acting Secretary, 2032 Belmont Rd. N.W., Washington, D.C. 20009

98

We are very sorry to report the death of **Walter Page** on February 15 of this year.

Next year **Bob Lacy, George Newbury,** and **Joe Riley** will celebrate their 97th birthdays!—**Mrs. Audrey Jones Jones,** Acting Secretary, 232 Fountain St., Springfield, Mass. 01108

03

After reading our Class Notes in the last *Review,* of the meteoric and astounding success of our classmate, **J. Howard Pew,** with his treasured family, we pause for reflection.

Howard's modesty during his long technical career is amazing in that he overcame obstacles in two World Wars as well as in peace. We now learn from news at his passing that as well as possessing a happy family life, Howard had a rare and deep religious background; unshaken by modern times. He never had a strike among his employers which numbered many thousands. He would be found in his office working at a straight chair and table which he preferred to an executive desk.

His personal interest in his employees was demonstrated once, when one of his employees was severely burned in an explosion on a research project. Howard visited him daily with reading material and encouragement until his recovery.

Howard was President of the board of trustrees of United Presbyterian Church for over 30 years. He and his brother and sisters also established the Pew Memorial Trust in his father's memory in 1948, with donations of Sun stock. In 1970, the trust made more than 200 donations, totaling more than $7 million.

A welcome letter from **Bill Eddy** of Salinas, Calif., says he is grateful for our remembrances on holidays and birthdays. He has celebrated his 89th birthday and his wife, Clare, her 85th. He has been fighting leukemia for the past five years when one seldom lives beyond two. He is unable to use his automobile for his occasional general contracting work. He still retains his license which he has had for 30 years. He spent a happy holiday with his son, Paul at Freemont, Calif., and was entertained royally. His only sad note is the recent passing of his brother, Harold, '07, in Course III at Long Beach, Calif.—**John J. A. Nolan,** Secretary-Treasurer, 13 Linden Ave., Somerville, Mass. 02143.

06

Homecoming Day was to be June 5 and we have sent in a request for luncheon reservations. Last year three men, two wives, and a guest attended—Stew Coey, Bob and Anne Rose, and the Rowes and Bertha Chase. Wonder who will show up this year! As part of its program and effort to cut expenses, the alumni officers have been removing "deadwood" from the alumni files. As a result I received a list of 12 names that had been so removed from the 1906 list. Of the 12, none had ever paid class dues or contributed to the alumni fund and only two had attended more than freshman year or part of it. These two were listed as '07 Special. By going through my card file and records I have found nine or ten more names that I believe should also be removed and I am so recommending to that committee. In contrast, there have been many more who have been loyal classmates—paid dues; gave to alumni fund; attended reunions; and perhaps have written to the Secretary.

Among those loyal classmates was Jim Wick Jr., who died March 16, at home in Youngstown, Ohio, after a very active, useful, and rewarding life. **James Lippencott Wick, Jr.,** was born in 1883, in Youngstown. His father had planned to send him to Case or Ohio State but the boy had his eye on M.I.T., so Mr. Wick agreed to see him through. After graduation, he returned to Youngstown and joined a well-established firm—the Falcon Bronze Co. He soon became general manager and treasurer. The company was sold in 1953 and Jim by that time had become immersed in civic affairs, historical research, and painting.

A clipping from a local newspaper took three 18-inch columns of small print to adequately describe Jim's career! He took an active part in the establishment and growth of Youngstown University and served as chairman of the board of trustees for almost 35 years. He restored to life the almost defunct Mahoning Valley Historical Society and actively supported the life of the arts, museums and community activities and also became an authority on the local history and personalities. When he retired, the local newspaper, *The Vindicator,* said "His courage, foresight, and understanding have made a record which would be a credit and joy to any man."

In spite of his constant activity at home Jim Wick found time to attend our class and M.I.T. reunions, with Clare, and correspond with the Class Secretary, whose files contain many letters and cards. The

05

Since my classmates haven't provided any news about themselves, I have to write about myself and my doings. But it's not too personal a story since it deals rather with the personal life of the M.I.T. Mascot, the beaver, and his capacity as an engineer: For a long time I had wanted something symbolic of M.I.T. to hang with my M.I.T. medallion on my hobby room fireplace wall. Having been frequently entertained by several colonies of beavers near my wife's brother's farm, I thus decided that the proper piece of beaver cutting might be symbolic.

So one night I drew a plan of what I wanted and placed it on the top of one of their dams. The next morning I found a piece of pine of the exact dimensions indicated in my plan, with teeth marks on both ends and all around the body where bark was chewed off. It was immediately mounted (see photo) and I of course wrote a thank-you note which I left on the dam. The next evening a flock of beavers clustered about the dam, flapping their tails, which meant, I am sure, "Anything for our Alma Mater!"—**Fred W. Goldthwait,** Secretary, Box 231, Center Sandwich, N. H. 03227

cards are of the lovely six-acre estate which he acquired in 1920. My last letter from Jim was in November 1971 and in it he told of removal of cataracts and the joy of really seeing.

His wife, Clare Mary Dryer, whom he married in 1908, died in 1970. They had a son, Dr. Warner Arms Wick, who is professor of philosophy at the University of Chicago and three daughters, Mrs. H. E. Thompson, Mrs. Walter Schaff Jr., and Dr. Emily L. Wick of Rockport, Mass., who is professor of food chemistry at M.I.T. and chairman of The American Chemical Society's division of agriculture and food chemistry. A letter of sympathy to the Wick children and grandchildren has been sent to Dr. Warner Wick.—**Edward B. Rowe,** Secretary-Treasurer, 11 Cushing Rd., Wellesley Hills, Mass. 02181

07

We are sorry to report the passing of **Arthur O. Christensen** of Beaufort, S.C., on April 26. After a degree in metallurgy and several years as a mining engineer in Mexico, he moved to Beaufort in 1920 and became engaged in land surveying.

Prior to receiving his degree from M.I.T., he attended Harvard University where he broke all strength and endurance records by lifting, in a half-hour, a total of 384,025.8 foot-pounds. In 1937, at the age of 55, Mr. Christensen placed second in the five-mile marathon swimming race sponsored by the city of Charleston. At the age of 70 he took up water skiing and for more than 10 years participated in many water skiing events including appearances in several Beaufort Water Festivals as the oldest skier in the world. In 1958 he skied from Beaufort to Savannah on one ski at the age of 75. Mr. Christensen leaves a sister, two daughters, eight grandchildren and three great-grandchildren. . . . **Herbert W. Day,** of New Haven, Conn., died November 13, 1971 at the age of 91. An engineer and physicist, Mr. Day received his degree from M.I.T. in mechanical engineering and was a member of the American Institute of Physics and the Professional Engineers Society of America. He leaves a daughter, a son, and one granddaughter.

A clipping from the March 23 *New Canaan* (Conn.) *Advertiser* features highlights from the professional career of **Walter B. Kirby,** architect and painter. The New Canaan Historical Society has recently received the complete records of the work of Mr. Kirby who for many years maintained an office in New Canaan and designed a great number of homes and buildings in the area. Some of his most noted works include the firehouse in New Canaan for which his design won the competition for the proposed building in 1937, the old post office (now State National Bank), and the buildings of Pepperidge Farm in Norwalk. Mr. Kirby's professional philosophy holds that "a good house should include shelter, convenience, and beauty . . . and . . . should be designed to fit the owner and his way of living, being also a background of the cultural, social and intellectual life of the family members."

Now in his 87th year, Mr. Kirby, enjoying retirement in Lakeville, Conn., keeps busy and finds pleasure in his avocation of landscape painting.—Kathy Sayre, Class Notes Editor, Technology Review, E19-430, M.I.T., Cambridge, Mass. 02139

11

Continuing the story of my calls on classmates where I left off in last month's Notes: I visited Marjorie and **Fitz Fitzherbert** at their fine estate in Wellesley Hills in the early fall. When they bought their land and built their home a generation ago, they were among the first to settle in this beautiful section of Wellesley. For a number of years the Fitzherberts have spent their winters on Mallorca in the Mediterranean, but this year it was not as good as usual because Marjorie broke her wrist shortly after arrival and had it in a cast for five weeks. On their arrival home in March they saw for the first time the last of three great grandchildren.

Last fall Dorothy and **Oliver Powell** spent six weeks touring England, Scotland, France, Switzerland, Spain, Morocco and Portugal. They returned to their home in Glendale, Calif., by way of Doylestown, Pa., where they spent Thanksgiving with their daughter. Oliver likes to play bridge and does a lot of walking and yard work. . . . From Oliver I learned of the death last March of Howard Ireland's widow, Winifred, in Glens Falls, N. Y.

I have just received belated notice from the Alumni Office of two deaths. **Ethan Alexis Collier** of Salem, Ore., died April 18, 1970. He was born in Eugene, Ore., October 21, 1887, and graduated from the University of Oregon before coming to Tech where he took up civil engineering. . . . **Austin W. Brooks** of Falmouth, Mass., died in April, 1971. He was in the electrical engineering department but did not graduate with us.—**Oberlin S. Clark,** Secretary, 50 Leonard Rd., North Weymouth, Mass. 02191

12

By the time you receive this issue, written in mid-April, our 60th reunion will have been a thing of the past. We are planning to prepare a detailed report on the event for the fall issue of the *Review.*

Dave Guy writes that he and Iva plan to attend the June festivities. "How is my general health? Everyone says, 'You are looking fine', but what is health at 86? You may have heard about the fellow who lived his whole life in a Mississippi River bottom and was afflicted with chills and fever. When asked why he didn't move away, he replied, 'Because I've lived here so long that I'm afeared I might not have good health no whar else.' Sir William Murdoch, Chief Justice of Ontario, at a dinner given on his 95th birthday, said, 'The testimony that I bear is that the castle of enchantment is not yet behind me, the best of life is always farther on.' And, on growing old, Thoreau wrote, 'Go confidently in the direction of your dreams.' As for me, I'll take Milton's pill, 'Sweet Contemplation', and join with John Masefield in his poem on the subject: "Be with me, Beauty, only stay quiet while my mind remembers the beauty of the fire from the beauty of the embers.' I do think the 80s have much capacity for enjoyment and time for contemplation when one can still use his own brain. As for the 90s, I say, 'That is the embers age.' "

Fred Busby writes, "I have no complaint as to my health although I well know that one and one-half packs of cigarettes daily are too many. I could no longer run on the cross country team; it is no longer easy to run to the telephone. As you know, I stopped teaching a year ago, so now I keep busy at home painting walls and woodwork. I have 15 grandchildren and three great-grandchildren, and expect my fourth and fifth very shortly. I shall look forward to seeing you in June, and trust that many others will be there as a tribute to your fine efforts." Thank you, Fred. . . . **Phil Dalrymple** says he is continuing to work as an executive of Jackson and Moreland in Boston. He is pleased to report the birth of his first great-grandchild, a boy. . . . **Phil Jones,** our latest bridegroom, reports that all is going splendidly in Naples, Fla. They did not attend the reunion due to the long trip to Cambridge, although both are in good health.

Al Thompson surprised me with a contribution which was sent from his convalescent home in Roanoke, Va. He says he is now in reasonably good health and forwards his best wishes to all classmates. . . . **Clarence Woodward** could not attend the reunion as he had planned to attend the graduation exercises of his granddaughter. His health has been good except for an accident on the ice last winter, resulting in a fractured hip, followed later by a strained back due to unusual exercise. So he spent two months indoors with extensive reading, including his favorite subject of astronomy. . . . **Harold Brackett** and his niece, Eleanor Forbes, took their winter vacation this year at Delray Beach on the Florida east coast, so we missed our visits with them on Longboat Key. . . . Sad news was received regarding **Paul Lawrence** from his son, George. Last November, Paul suffered a stroke and is presently in a nursing home near Pittsburgh, Pa. He is fairly well physically but mentally is quite confused. He is also affected with congestive heart trouble, so may be confined to the nursing home for a long period. His spirits are good, however, and he asks to be remembered to all his classmates.

Carl Rowley wrote explaining that other matters will prevent his attendance at the reunion, but sends best wishes to all. His plans include the regular annual trip to his Cape Cod cottage in Harwichport to get things ready for his large family, who always occupy it during the summer. . . . **Ham Merrill** writes that he will be busy just before reunion attending graduation exercises of a grandson, followed by the marriage of a granddaughter at Georgetown, Me. He expected to be with us for the class dinner and Homecoming Day, however. . . . **John Hargrave** wrote to explain that he will be unable to make the trip to the reunion, presumably due to his severe arthritis.

Jack Connolly also wrote from Ponte Vedra Beach, Fla., stating that he and Hazel continue to enjoy good health but have decided not to attend the reunion. . . . **Jerry Hunsaker** wrote that he planned a May fishing trip for landlocked salmon and togue, trolling from a canoe propelled by a small outboard, nursed by a talkative veteran Maine guide. He will stay at Quartet Camp on Grand Lake, Me., as usual. Jerry says his health is "in fair shape" and that he still keeps his Adirondacks summer cottage, where he engages in trout fishing in the Ausable River. As we know he still lives on Louisburg Square, Boston where he entertains family and friends. He also maintains his office at Tech, and also maintains membership on the Guggenheimer Medal Board and is a trustee of the Museum of Science. A pretty active person at 85!

Charles Willis is well and still maintains an office in Lexington, Mass. He keeps busy promoting his specially designed, low cost homes, making possible the erection of attractive structures, usually at a cost of some $11,000. Good work, Charlie; you are one of the 12 classmates still gainfully employed. . . . The **Chet Dows** of Cleveland did not attend the reunion although their general health is good. They left in May for their 36th trip to their summer camp on Lake Madison, about an hour's ride from home. . . . **"Mac" MacCormack** reports a new great granddaughter, Daphne born March 21. Congratulations!

Willis Salisbury left in February for a three months trip to Hawaii. He will be at the reunion. . . . It is doubtful whether **Ken Barnard** will attend the June festivities. He is still employed as a research chemist for the Colonial Candle Co., near his home on Cape Cod, and works there every morning. He has a large family, three children, seven grandchildren and ten great-grandchildren who visit often.

John Hall writes from New Jersey that the reunion trip is more than he can now take. Sorry, John, we shall be thinking of you. . . . From **Nelson Breed,** "My wife, Marjorie, and I spent most of last summer on Block Island, R.I., and stayed until a week before Christmas. This gave us time almost to finish our house on the island. We spent the winter on the Isle of Capri, near Naples, Fla., and had a grand time swimming and fishing. We practically lived on fish and found it a good, healthy diet."

It is our sad duty to report the passing of **Alfred P. Morgan** in Upper Montclair, N. J., on March 16, 1972 after a short illness. He took a special course with us for but one year, as published in the October 1971 *Review*. He had four sons and 15 grandchildren. He won recognition in *Who's Who* for his developments in radio telegraphy and was also a writer of children's technical books. The sympathy of our Class has been extended to his wife, Ruth, and the family.

Our latest report on **Jonathan Noyes** is that he was recovering normally from his heart attack, but that he was still very weak and his eyes were giving him trouble. He is most disturbed that he will probably not make the reunion. The entire Class of 1912 are rooting for you, Johnny, and hope that it will not be long before you are again about.

In another week or two, Helen and I plan to leave Florida for Swarthmore. We have decided this will be the last year that we shall winter in the South.—**Ray E. Wilson,** Secretary, 304 Park Ave., Swarthmore, Pa. 19081

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The Alumni Days of M.I.T. in 1972 will be held on campus Sunday, June 4 and Monday, June 5. The illustrated brochure for the homecoming days has been received. It is hoped that the usual 1913 members will attend, also many more of our seldom participants will join us. Already the **Ellis Brewsters, Charlotte Sage,** and the **Phil Capens** have registered. We have been in frequent communication with William R. Mattson, our President and Ellis W. Brewster, our Alumni Fund Agent. We appreciate their cooperation and advice.

Frank Achard wrote us regarding his latest activities and we quote: "As I told you by phone Margaret Mall Richardson and I were married 18 December 1971 at a quiet wedding in her home in Newton Upper Falls. We are living there now. Margaret was in the 1922 School of Architecture, M.I.T. and earned her B.S. degree and taught at Tech for 17 years.

At an Alumni Council meeting I attended, the speaker emphasized the need for engineering technologists to relate to the economic and other social patterns of the people. Parenthetically this would be a good idea for all technologists, health, government, judicial systems, social systems and executive and administrative systems."

We are indebted to the Alumni Fund organization for several notes from two of our classmates. **Charlotte Sage** states: "Same house, same pleasing job—running it—same pleasing family, plus two great-grandsons; same Chevy II and praise be, still running it." . . . **Robert Tullar** adds: "Mrs. Tullar and I spent part of our winter in Coronado, Calif., with our daughter and grandchildren, and with our nephew in Tucson, Ariz. The Sun Cities are beginning to look better and better, but we still are at the old home—same one for 50 years come May 1."

A note was received from Mrs. Martha F.

Cannon in Cedar Rapids, Iowa 52403. She is the daughter of Dr. **Paul V. Faragher:** "My mother and I appreciate very much your card of sympathy on the loss of my father. I don't know how well you knew Dad, but he was very alert and active, keeping up with his reading, gardening, and music (via the stereo) till the end. He, mercifully, did not suffer. Please extend to the members of the Class of M.I.T. our gratitude. Thank you for your card."

We were particularly pleased to receive a long overdue letter from our classmate, **Edward M. Bridge,** together with a tabulation of his activities since graduation: "Retired from my practice as an architect, I at last am writing. I shall be 82 on June 26, and have good health and work inside and outside on our one-acre estate, where we have lived for 52 years. I also enjoy working in my cabinet shop attached to my two-car garage. I have spent some time going over my extensive business records to prepare my memoirs, a copy of which I enclose. Caroline, my wife, 83 years last January is not now well and it concerns all of us. She is under constant nursing care here in the home. Memories of my teaching experience come back clearly. Best wishes to both of you." We have a summary of his various accomplishments and interests: As an architect, he participated in 60 church projects, 22 projects in Wakefield, Mass., and vicinity, 12 public service activities in Wakefield, several projects in Belmont, Cambridge, Lincoln, Marblehead, Washington, D.C., and Dartmouth College. Edward was a professor at M.I.T. in the architectural department. During World War II, he served at the Lowell Ordnance and with E. B. Badger Co. Many thanks, Ed for "This is my Life." To you other retired classmates, take your pen in hand and let us learn of your activities.

Again it is our duty to report the death of one of our classmates, Dr. **Maurice G. Berlin,** who passed away March 2, 1972 as reported: "Funeral services for Dr. Maurice G. Berlin, 81, an obstetrician and gynecologist, were held at the Levine Chapel, Brookline. Dr. Berlin of 77 Louise Rd., Chestnut Hill, died in Jewish Memorial Hospital in Roxbury after a long illness. Born in Russia, he was educated at M.I.T. and was a 1914 graduate of Tufts Medical School. In addition to his medical practice, he was founder of the Birch Hill Camps for children in New Durham, N.H. He was a member of the American Medical Association, the Massachusetts Medical Society and the Greater Boston Medical Society. He was also a longtime member of Congregation Kehillath Israel of Brookline. He leaves his wife, Miriam (Cushing) Berlin; a son, Donald, two daughters, Shirley Kahn and Doris Schreiber; a brother, Dr. David D. Berlin; a sister, Mollie Lyon Gordon and nine grandchildren.

Change of address—**Edward Hurst,** 32 Westwood Rd., Shrewsbury, Mass. . . . Until next month, write us the story of your life. We shall attend the Alumni Day, June 4-5, 1972. Will you?—**George Philip Capen,** Secretary and Treasurer, **Rosalind R. Capen,** Assistant Secretary, Granite Point Rd., Biddeford, Maine 04005

Tribute to Marshall Dalton

Though it was officially a private fraternity affair, Phi Gamma Delta's tribute to Marshall B. Dalton, '15, early this spring turned out to be a boisterously festive banquet graced by most of the principal administrative officers of M.I.T. as well as a remarkable 25 per cent of the chapter's living membership.

Leading the speakers, James R. Killian, Jr., '26, (at left in the above photo) Honorary Chairman of the Corporation, recalled that "one of Mr. D's (Mr. Dalton's) most extraordinary and successful M.I.T. activities was to head the Committee on Financing Development that led a major capital fund-raising campaign in the late 1940's and early 1950's. At that time M.I.T. set out to raise $20 million and in the end raised $26 million, with Marshall Dalton quarterbacking the whole effort. . . . He was deeply involved, too, in planning the great Mid-Century Convocation which M.I.T. had in 1949, a celebration which brought Winston Churchill to Boston together with a constellation of distinguished leaders and scholars from all over the world."

Mr. Dalton became a member of the Institute Corporation in 1937 and a life member in 1943; in 1937-1938 he served as President of the Alumni Association.

In all his many M.I.T. activities, Dr. Killian added, "Marshall has brought to our corporate life qualities of sensitivity, friendly warmth, and unfaltering loyalty which, taken together, have made him a superlative trustee and a major resource for our institutions. . . .

"We hear too often today that no one person can hope greatly to influence the course of events against the inertia and troubles of our complex society, but I hold that such people as Marshall Dalton, working quietly and selflessly to help men and institutions, do indeed serve greatly to renew and revitalize the moral strength and the quality of our society."

Robert R. Mohr, '72 (at far left in the photo) chairman of the fraternity's dinner committee, noted that the affair had attracted fully one quarter of his chapter's living membership, and William S. Zerman, executive secretary of the Phi Gamma Delta national, spoke gratefully of Mr. Dalton's service to the fraternity.

Mr. Mohr presented Mr. Dalton (see above photo) a book signed by everyone present, as "a testimonial of what Mr. Dalton has done for this chapter and a record of more than 60 years of service to this fraternity and M.I.T. . . . His advice, guidance, and distinguished service have been of enormous benefit."

Howard W. Johnson, Chairman of the M.I.T. Corporation and a member of Phi Gamma Delta, proposed a toast to Mr. Dalton.

Accepting the tribute, Mr. Dalton was speechless: "In the face of a tribute like this, what can one respond? It baffles me."

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Mrs. William Peterson (whom you'll remember as Florence Richmond) wrote me a very welcome letter, early in April, from Delray Beach, Fla. (86 MacFarlane Dr.). It's a pleasure to quote from it: "Bill and I are living here permanently and enjoy it very much. This has been the best winter in 23 years, weatherwise, and we were happy to be away from the snow and ice in New England. Bill and his deceased wife were our very best friends for nearly 40 years, and we often traveled together. Our children used to sail together, so our families knew each other well. We are going to Centerville, Mass., (Cape Cod) on the Auto Train on May 26, for the summer. If any of Harold's classmates are in the vicinity of Centerville or here in Florida, we would love to see them."

Sorry we had to cancel our 58th Interim Reunion for lack of numbers, due primarily because of geographical distribution of our classmates and other commitments.—**Charles H. Chatfield,** Secretary, 177 Steele Rd., West Hartford, Ct. 06119

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We hope you get these notes in time to be at our Annual Class Cocktail party and dinner, Monday afternoon, June 5 at 4 o'clock at the M.I.T. Faculty Club. This has become an outstanding class event thoroughly enjoyed by all who attend.

In February, **Louis Quirk** wrote from San Diego, Calif., that he was there on his annual hibernation, enjoying clean, warm weather and no rain and hopes to be with us at the June 5 party. We'll be glad to see him. . . . Alice Anderson had a fine South Pacific cruise on the *S. S. Monterey.* On her return she stopped in Michigan to see Andie's son and his family. . . . From Winnetka, Ill., **Sam Otis** writes that he is retired and trying to promote two of his patented inventions.

On a visit to Martha's Vineyard, I had lunch with **Charlie Norton** but was sorry to miss his good wife, Bee, who was off Island. . . . Later, I saw **Frank Atwood,** 1914, who is a big real estate and motel operator down there. . . . **Phil Alger** sent me an autographed copy of his latest book *The Human Side of Engineering,* a very interesting series of anecdotes, of the famous General Electric engineers whom Phil knew in his 50 years association with that corporation. Keep well and write when you can.—**Azel W. Mack,** Apt. 26A, 100 Memorial Dr., Cambridge, Mass.

16

It's here—our 56th reunion, on Tuesday, Wednesday and Thursday, June 6, 7 and 8, following Alumni Day on June 5, and we'll celebrate again on the Cape in Chatham, where we have had so many of our invigorating get-togethers since the 35th in 1951. As our ever-outgoing president **Ralph Fletcher** says: "We will return to Chatham Bars Inn where they offer a scenic location, wonderful food, excellent facilities and have always been generous with their attention to our needs."

Dolly and our faithful Assistant Secretary, **Len Stone,** who had been "fixing" to get a vacation from writing this column, returned on April 6 from three weeks on Young Island, St. Vincent, West Indies, with more than a trace of Caribbean tan. We received from them a come-on-down picture of the bar that is "the center of social activity of Young Island." . . . With a new Buick **Dave Patten** and Dorothy cranked up and headed for New York and Washington, for annually on January 26, a group of former staff members meet for dinner on General MacArthur's birthday. He says: "The Air Force flew us down to Norfolk, Va., for lunch and a meeting at the MacArthur Museum. In the evening there was a banquet at Fort McNair. About 90 attended. We were guests of the Army-Navy Club." Dave often reports on luncheon meetings of the M.I.T. Alumni, where in February, **Barney Gordon** showed up and appeared in good form.

We've had just a bit of a problem on deciding how best to report what **Francis Stern** has to say about himself. No problem at first as he notes that his grandson who has his Ph.D. from Yale, is teaching and published two math articles only recently. His granddaughter has two years toward her Ph.D. at Berkeley. Then Francis says: "It's great to have brains—even two generations removed! Me—I got a P once, etc." How does one report such things when trying to give only the best about 16ers?

Along toward the start of spring, **Frank Hastie** of Dowell, Md., had a few cogent remarks about some of the problems of winter, "I could do just as well without my 'Old *Farmer's Almanac*'—how wrong can its forecasts get? It is not that I mind the snow itself, but the stuff they put on the roads—salt. Sometimes I think our civilization is becoming too sophisticated. Let traffic move slower for a day or two. After all, what does it matter? But, of course, the older I get, the fewer things matter. Just family and friends!"

We'll exhibit at the reunion, a picture from the *Palm Beach News* of March 5 showing **Jap Carr** in quite another role than the one we recently saw pictured in the *Review,* at the tennis courts at Tech. This new picture carries the caption: "Up in flames goes the mortgage on the headquarters building of the Palm Beach Chapter of the Red Cross. Holding the document is J. B. Carr with an assist from Joseph Manning, catering manager of The Breakers." This just-finished mortgage reduction program was one Jap started five years ago but had to stop on account of a coronary. And can you guess what Jap was doing a month ago in Florida? Playing tennis with Dina Merrill—actually—ask him! . . . **Nat Warshaw** still puts in three hours every morning in the office, for which he is ever grateful now that he is alone. Accompanying his son Stan on a convention trip out west, his reaction was two-fold in Las Vegas, (a) "Who said there was any such thing as poverty?" and (b) "The Folies Bergere were almost the same as I saw 54 years ago in Paris!"

If anyone wants to compare what kind of birds are seen near breakfast-room windows, we suggest writing to either **John Gore** in Canajoharie, N.Y., or **John Fairfield** in Troy, N.Y. John Gore's latest report includes a snowy owl. Others include pine siskins, gold finches and a flock of redpolls. For John and Gladys Fairfield it's pheasants and grosbeaks. They recently unearthed trunks that housed such treasures as John's letters before they were married. Thinking of days gone by, John F. says: "I came back from Europe with just 5 cents and we came back from honeymoon with a quarter—now we feel timid if we venture out without a bill or two and a credit card."

Allen Pettee of Tryon, N.C., was one of seven what he calls "ancients" to be honored as Fellows-for-Life by the local (Asheville, N.C.) chapter of the I.E.E.E. recently. He says they were displayed to a few student members as presumably end products of engineering careers. And what do you think is Allen's retirement avocation? Dabbling away at his "Sunday" painting, at a current rate of only about four a year, so that years from now each can be classified by his grandchildren as a rarity! "At the moment I am finishing a view of the partially restored Labyrinthine palace of Minos of Gnossus in Crete, of which I snapped a good slide back in 1962. The place where Theseus, the Athenian, slew the maiden-munching Minotaur and conveniently found his way back out by following a thread which Ariadne handed him at the entrance."

Spotts McDowell of Pittsburgh took a trip out west last fall to visit a sister in the San Diego area and stayed at the old but charming La Valencia in La Jolla. As for Spotts' philosophy: "At my present age, there are two maxims that have special appeal to me, in this period of almost unbelievable rapidity of change: 'Hold fast to that which is good.' and 'Accept conditions you cannot change.'" . . . **Jerry Reen** of Springfield brightly indicates that he and Blanche were enjoying the beautiful weather at Marco Island, Fla., in February, admitting that the two-mile walk on the beach seemed much easier each week. . . . And from **Shatswell Ober** in Arlington comes approval of the 55th reunion picture: "A group of handsome men except for some instances of thin hair on top—the same for the ladies without the exception."

Victor Dunbar, way up there on Cape Breton Island, Nova Scotia, certainly inspires us to get out our best *Atlas* and see where all those places are located—the ones he and his professor son Don have visited since locating in Sydney. He tells of taking a ferry, mind you, for a 265-mile trip from north Sydney to Argentia in Newfoundland, "famous as embarkation point for thousands of American soldiers in World War II and as the place where the Atlantic Charter was signed by Roosevelt and Churchill in 1941." Also we read about a 1000-mile, 25-hour Canadian Pacific train ride from Sydney to St. Lambert, Quebec. Says Victor: "How good to ride a train again—a clean 14-car one to boot, with excellent meals and courteous service." . . .

Jim Evans reports that he was the only 16er (just two 17ers, including Dick Loengard, of course) at the April monthly 1916-17 luncheon at the Dartmouth-Brown-M.I.T. Luncheon Club in New York.

And now the 56th reunion, then a happy and healthful summer. Our report of the 56th doings will be given in the first issue this fall. In the meantime, keep well, keep busy, and write a little but write often to your willing-to-work secretaries, to help them keep, the little old column full and interesting.—**Harold F. Dodge,** Secretary, 96 Briarcliff Rd., Mountain Lakes, N.J. 07046; and **Leonard Stone,** Assistant Secretary, 34-16 85th St., Jackson Heights, N.Y. 11372

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The reference in the May notes to the grandson of **Poh Y. Hu,** student Chi Kuan Wu, has had an interesting sequel. An airmail letter from Poh Y. to your secretary contained mail for Chi Kuan, some of which had been returned to Singapore by an unfortunate delivery situation. As a result Poh Y. became worried about his grandson. Through the Institute Chi Kuan was located in his Cambridge dwelling, and an interesting visit resulted along with the delivery of the mail. In that mail was a letter in beautiful Chinese characters which Chi Kuan proudly stated was typical of his father's generation.

Conversation developed the fact that Chi Kuan had received a non-interest bearing loan from a "Class of 1917 Scholarship Loan Fund", of which your officers had no recollection nor were they aware of its existence. Who among us remembers such a fund being started at the time of our 25th Reunion? While contributions dried up, with accumulated interest the fund grew to $3,038. In 1964 it became formalized under the above title and available by first preference to a descendant of a member of the Class of 1917. Chi Kuan's relationship evolved and the full amount of the fund has been loaned to him against his promissory note. So to those of you who did contribute to that Fund, a thank you for helping a worthy young man.

The most recent of the '16-'17 lunches in New York have been held in the Dartmouth-Brown-M.I.T. facilities in the Hotel Commodore. The bar is spacious in a good-sized room equipped with tables and comfortable chairs, but separate from the main dining facilities. Any member of the Class who would like to receive notices of future lunches should send his request to your Assistant Secretary.

"Tubby" Strout has received a card from **George Henderson** saying he hopes to be at the Reunion, as do the **Cy Meddings**, but these classmates from Virginia all feel that physical difficulties may make it impossible. . . . **Ossie Holt** writes him that he is sorry to miss out on the 55th, but has hopes for the 60th. **Rad Stevens** and **Sam Creighton** will not be at Chatham Bars, but send regards and best wishes to all their classmates, as does **Vincent Panettiere** who regrets he cannot attend because of ill-health. . . . **Dick Catlett** has reluctantly decided that they will not be able to come to Chatham Bars this year. They are getting along well with their various activities, however. Dick sends his very best to all classmates.

Leon Keach writes "No retirement yet contemplated or wished upon me; a happy situation at 78 but it is unlikely to obtain many more years, fingers crossed or not. I'd settle for two, with the privilege of an extension if my digestion was still good.

With great regret we report the death on January 29, 1972 of **James W. Anderson** of 101 North Fig Tree Lane, Plantation, Fla., 33313. . . . We are saddened to learn also of the death on January 27, 1972 of our classmate **Walter A. Wood**. Wally will be remembered at our early reunions for his lively performance on the accordion. . . . We are sorry to report also the death of **Franklin C. Dexter** on March 20, 1972.

These notes are brief, and we hope the *Review* will bear with us if we go to somewhat greater length in reporting outstanding happenings at the reunion in later issues.—Reunion Chairman, **Henry E. Strout,** 48 Parker Rd., Osterville, Mass. 02655; **Stanley C. Dunning,** Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard,** Assistant Secretary, 21 East 87th Street, New York, N.Y. 10028

18

Sometimes the business of being your Secretary requires the patience of Job and the wisdom of Solomon. Such an occasion took place today when an irate classmate wanted to know what I could do concerning a joint statement made by our Prexy and other college presidents protesting the escalation of the bombing of North Vietnam by U.S. Armed Forces. My answer—right or wrong—calmed him down. It suggested that the statements were the personal beliefs of these individuals and not the official position of the universities concerning the war. Furthermore, anyone is free to express his opinions in the press. But how do we get our views in large print on the front pages also, so these presidents can see it? And doesn't the public believe that these statements reflect the whole university? This problem, kind reader, we leave to you to cogitate, and send me the solution.

There are times when there is a lassitude—spring feeling—and your news to me is at a miserly minimum, so I resorted to the telephone and gleaned a few items; **Charlie Dow** just returned from four months at Long Boat Key, near Sarasota, Fla. He is in fine fettle, expects to be busy with his daughter moving into his house. As a result he will not only nurture his flower garden with loving care, but will add a vegetable patch. Charlie is also a Sunday painter—water colors. . . . **Mike Flett** who retired from active business a few years ago, has a small estate in New London, N.H. Gardening is his hobby. Mike has been suffering from arthritis but with the treatment of large doses of vitamins C and E is nearly free of the affliction. Keep up the good work!

Jack Purves is fully retired—devotes some time to Red Cross—does much reading—but little travelling. He reports that he almost bumped into me at the supermarket but lost me in the crowd. Next time, ring the fire alarm. . . . **George Sackett** is making a good recovery from a heart situation last summer. He has dropped from 195 to 155 pounds in weight—walks a mile to the beach and with continued therapy expects to have full use of his left arm soon. His new manual for retired readers (auto tires) has had a wide acceptance. We expect to see George and Marle at our fall get-together at Endicott House in October. . . . **Pete Strang** is busy writing his technical abstracts. His wife broke her hip and is temporarily in a rest home. Hopefully she will be released to go home shortly. He is listed in the 1971 *Dictionary of International Biographies* published in London, England in which there are some 2000 names.

George Ekwall, our retired minister is busy pitching in with relief jobs when his successor is unavailable for sermons, weddings, and so on. In the interim, he is busy maintaining the grounds of his plot next to the brook in the centre of Waltham, Mass. . . . Mildred and **Charlie Watt** leave in early May for their annual golf sojourn in Pinehurst, N.C. He has recovered from an eye infection. He and I both hailed from Lexington, Mass. Charlie reports a friend sent him a copy of a 1910 *Lexington Minuteman* paper in which there was a picture of the school color guard. He was able to distinguish himself as captain and me as sergeant. . . I am happy to report the **Julie Howes** are busy getting their garden ready for a gala year. In particular—wonder of wonders—Elizabeth has recovered from her broken hip of last September—and has thrown away the crutches, Hooray! . . . Earlier this week I saw the **Al Grossmans** and the **Leonard Levines** at a community dinner—all were in good health. Stella G. is to be congratulated on a special birthday.

Wingate Rollins reports visiting New Orleans, Mexico City, Cuernavaca, Taxco, Los Angeles, Las Vegas and San Francisco in February. . . . Most faithful **John Abrams** reports his activities in February as follows, "Good old Brick Dunham was my roommate on St. Botolph St. Sam Chamberlain lived down the block and we used to dine at the Waldorf cafeteria at Mass. and Huntington. Through Sam I met my first wife, a childhood friend of his. Aren't they fine fellows to cherish as friends for over half a century? At the geothermal steam conference (I was a pioneer in 1961) milling around 'til after midnight I felt like an elder statesman—78 on February 1. This week I brought in ten tons of fieldstones to build natural revetments on the meander of our brook. Today I've been up a double ladder topping and shaping trees.

"More labor tomorrow: no social activities, plain meals by a superb helpmate of 25 years—21 years my junior—and the daily satisfaction of a good life through the halcyon days before 1914. There's a feasibility report to be tackled on a natural sulfur deposit near Death Valley! But Henry Abrams back in the 1700s lived to be 108!"

Thanks to Len Levine, here is a most interesting biography from **Oscar Andersen,** "In the Ordnance Department, Wash. D.C., my first assignment was to redesign the carriage for the French mm gun using readily available structural shapes to facilitate high speed production. Under Edward Ryerson, '09, I acquired experience in the use of structural steel during two years in the family's company, Joseph T. Ryerson and Sons. The military service was physically beneficial and a teaching assignment in surveying was a welcome relief.

"An important period in my career was from 1922 to 1934 at Pettibone, Mulliken Co., Chicago, where I became involved in a modernization and expansion program. Several patents, and promotions, ensued.

"In 1938 my family and I moved to Los Angeles and built a home in Baldwin Hills, where I started the Andersen Engineering Co. A year before Pearl Harbor, the Douglas Aircraft Co., requested help in a design to check compasses on their new bombers. The result was the Andersen Compass Rose used nationally and in Europe.

"Permit me at this point to tell you just one episode. It took place at Orchestra Hall in Chicago. It was the last number on the program—Beethoven's Piano Concerto in C Major with the Chicago Symphony. The pianist was a little girl, 15 years old. Her name was Margaret Andersen. No, she was not my sister, nor even an acquaintance. Several years later, she married. The fortunate man was Oscar Andersen. She gave me a son, Burt, who, with his mother's musical gift and his father's creative ability, has brought me much happiness. He is Art Director at Hughes Aircraft Co., and has won national honors in his field. He is married and has two daughters. Mrs. Andersen passed away in 1964 and I retired in 1968."

Selma and I will be away in May—mostly in Yugoslavia. These notes will be in the capable hands of Len Levine. . . . New addresses: Philip B. Craighead, 15 Orchard St., West Yarmouth, Mass. and Donald C. Goss, 230 Washington St., Marblehead, Mass.—**Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass.; **Leonard Levine,** Assistant Secretary, 519 Washington St., Brookline, Mass.

19

Ed Moody, R.F.D. #2 Nashua, N.H., Phone 603 889-4297 invites all classmates who are heading his way to stop in and sample his guest room and wife's cooking. He is 40 miles north of Boston and 100 miles south of Mt. Washington. Ed had a bad break—his hip, caused by a fall on the ice in February. He will be back on his feet again in May. Best of luck Ed!

Ervin M. Kenison plays lots of duplicate bridge and shuffleboard in Bradenton, Fla. He reports the summers there are not bad and the people are very friendly. . . . **Harry Cikins,** of Brighton, Mass., expects to move to sunny Florida in the fall. As he puts it, "The old bones are beginning to squeak." . . . A letter from Foster P. Doane, Jr., '20, from Neenah, Wisc., asked for the address of **Dan Hall** and **Roger Hall.** They all went to high school together in Arlington, Va.

A party at Delray Beach in late March was attended by **Howard McClintic** who is in good health—plays lots of golf—also Tom Price, '25, Red Lusignan, '25, Frank Kurtz, '22, Ted Riegel, '22, Louis Metz, '23, John Newall, '34, Allen King, '22, Bob Bradley, '20, Bob Hallock, '22 and Sam Groves, '34. They are all winter residents in the area of Delray Beach.

Again best wishes for a fine summer to the Class.—**E. R. Smoley,** Secretary, 50 East Rd., Delray Beach, Fla. 33444

20

Let us hope that the current news famine from the good Class of '20 is occasioned by the fact that everyone is busy and happy, with many coming north from Florida to enjoy the summer advantages of the northeastern coast. Since these notes will appear after Alumni Homecoming, we shall express the pious hope that the next issue of the *Review* will contain a goodly list of classmates present; for the program and the "Pops" certainly promise much in the way of enjoyment.

A note from **Bill Dewey** indicates that by now he and Barbara are back at their home in Springfield. They spent the winter at Treasure Island, Fla. I might mention that Shawmut Inn at Kennebunkport, Me., proved all it was cracked up to be when visited in April by the **Myron Clarks** and the Harold Bugbees. We recommend it for a summer weekend or longer. It is beautifully situated, right on the Atlantic.

Francis Sears of Norwich, Vt., writes that he and Mildred had reservations on the ill-fated *Lindblad Explorer* which went aground in Antarctic waters. The Sears were planning a cruise up the west coast of South America and the Galapagos Islands which had to be cancelled. They settled for a cruise to the Mediterranean and the Black Sea on the *Hanseatic.* We trust they return safe and sound.

Late word from Bill Dewey, in response to an inquiry as to his attendance on Alumni Day, indicates that he may have good reason not to be there because one of his grandsons is getting an eagle scout award in Springfield, Va., where Bill's son, Bob, a Lieutenant Colonel, and Bob's wife, who is Barbara's daughter, provide a pleasant stopping point—Springfield to Springfield—for the Deweys en route north. I know how proud Bill must feel as I attended my grandson's eagle scout ceremony in California last year.—**Harold Bugbee,** 21 Everell Rd., Winchester, Mass. 01890

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A footnote to the career of the late **Raymond Fisher** of Seattle, Wash., was supplied by **Ralph Shaw** of Beverly, N.J. He wrote that Ray as an employee of Pacific Telephone in San Francisco, sold the Bell System "on the idea of using vacuum tube boosters every 100 miles across the country." For a long time he was engaged in putting them in. I was in Fresno and Ray phoned that I could talk to my father in Chicago free—in seconds Father came on the line." Ray also invented and patented an electronic organ, made like a regenerative radio set that oscillated. Said Rufe, "Ray was a hell of a nice fellow." . . . Rufe himself is a many time inventor. Two or three years ago Rufe got a patent on a new machine to blend U-bolts used to fasten spring clips onto the axle of motor trucks. "These bolts were formerly drop-forged, requiring forge shop, drop hammers, and a crew of eight to ten men to man them. It took about four to six hours to make the bolts. My machine takes a straight heat-treated bar and makes two right angle bends in 30 seconds in a one-man operation. The saving is about $400,000 a year in a big shop."

The March 3 issue of the *New Jersey Coast Star* reported the return of Mr. and Mrs. **Carole A. Clarke,** to their home in Brielle, N.J., after a two-month stay in Mexico. They spent a month in San Miguel de Allende, studying at the Instituto Allende. Maxine enrolled in two advanced art courses and Cac took courses in writing and photography. They both studied Spanish. Cac writes, "We undoubtedly had the best time and finest and most unusual experiences of all of our three trips to Mexico. Classes ran from Monday through Saturday—work was not easy—plenty of homework and a lot of preparation in the photographic lab. For relaxation, we took house and garden tours, attended a symphony concert and numerous fiestas. We had a most unusual experience at a 'coloquio', a Spanish miracle play performed on a makeshift stage in a huge field; attended by whole families of 'campesinos' with food and cooking equipment; starting at 9 p.m. and running all night. We had several grand visits with Ruth and **Frederick F. Olson** of El Cerrito, Calif., who regularly spend part of the winter in San Miguel.

"Our two weeks in Mexico City were a wild succession of visits with our many M.I.T. friends. The 24th Annual Fiesta of the M.I.T. Club of Mexico City was the finest we have attended. The high spot was a privileged visit to the fairyland of the restored old hacienda of La Gavia. The 'Noche Mexicana' in the gardens surrounding the home of Clarence Cornish, '24, was the climax to the three day Fiesta celebration." Next March the Club plans a celebration for its 25th Annual Fiesta, and Cac urges classmates to attend for a delightful interim reunion. Those of us that have attended the Fiesta in Mexico can confirm that the Club does a wonderful job and provides a memorable three days.

The William Buckley Sunday night TV program, *Firing Line,* recently had a panel discussion of St. Augustine's *Confessions.* One of the three panelists was Dr. Sherwood E. Wirt, Editor of *Decision* magazine. A letter from Reverend **Williston Wirt** confirms that Sherwood is a younger brother. Will is now in his tenth year on the staff of the Pomona, Calif., Public Library. He is usually doing some research and presenting papers to

Rotary, Kiwanis, etc.

A note from **Richard W. Smith,** of Chevy Chase, Md., states that he is still tracing ancestors and is now working mostly on his wife's southern lineage. A year ago he wrote that he felt certain that he was distantly related to both Cac Clarke and Sumner Hayward. Your Secretary's wife, is a professional genealogist and on more than one occasion after meeting someone new, a little research brings forth the remark, "Well, you're kissing cousins."

Two appeals were received in March by **Albert E. Fowler, Jr.,** of Somerville, N.J., to write a letter to the *Newburyport Daily News,* plugging the fact that $140,000 had to be raised to restore the old Custom House in Newburyport to its former glory. The government sold it to a junk dealer some 30 years ago and for years it has been an eyesore. Now it has been declared an Historic Landmark and plans call for turning it into a maritime museum. After many starts torn up daily, Al finally produced the letter and the *Daily News* printed it. This Custom House was designed by the same man who designed the Washington Monument. The Fowlers plan to spend the summer at Plum Island, Newburyport, as usual. . . . A letter from **Chesterton S. Knight** of Brockton, Mass., tells of his retirement in February as a partner and machine designer in the firm of George Knight and Co., machine manufacturers. He and his wife Marion divide their time between Brockton and their other home on Martha's Vineyard. He invites his M.I.T. friends to drop in. . . . **Edwin F. Delaney** of Wollaston, Mass., reports plans to move to Naples, Fla. His wife Kay has had illnesses off and on which has made it desirable to stay near Boston. Now Kay's doctor feels that her health will permit the move to a warmer climate. Cheers!

A note on the back panel of an Alumni Fund envelope advises that **A. Ilsley Bradley** of Cleveland, Ohio was recently asked to teach "real estate" at Dyke College. He qualifies as an expert in this field after years of experience in the real estate and appraisal business. . . . Assistant Secretary, **Josh Crosby** had brief visits at his home in Sarasota with Win and **Royal Wood** who spent most of March at Siesta Key, and with Millie and **Don McGuire** who had been staying at Winter Haven. Over cocktails one night in February with the Haywards, Claudia Crosby told about a fishing experience years ago with Josh in the Canadian Laurentians. Casting with a fly rod, she flicked the line back over her shoulder, snagged the line (she thought) in Josh's gear, turned angrily to protest, and found she'd hooked a trout.

In the March/April account of **Saul Silerstein**'s last trip some highlights were omitted. While in India, the war with Pakistan was imminent and Saul experienced a blackout exercise in New Delhi. Amusing was his account and sketch of mounting a 6000-pound female elephant named Gulabkali. She "was dressed in her best—gold, silver, jewels—face and trunk artistically painted. I mounted via stairs while an elephant boy shouted and speared my gal into position. The ride was very rough, side to side, pummeling. Gula needs a gyroscope stabilizer." Saul sports a luxuriant bushy beard these days and on both of his last two trips was frequently greeted as Ernest Hemingway or Santa Claus.

Class photographer, **Robert F. Miller,** writes that the Caribbean cruise on the *Europa* in March was wonderful. High spot was the yacht haven on St. Lucia, the locale of the Rex Harrison movie, "Dr. Doolittle." Also given a high mark was a quiet and clean St. Maarten. Bob is going to assemble an album for the class archives of the best colored photos of the 50th Reunion. Please send him your best shots of people (not buildings), either Kodacolor prints 3½ × 5 or Kodachrome 2 × 2 slides.—**Sumner Hayward,** Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby,** Assistant Secretary for Florida, 3310 Sheffield Cir., Sarasota, Fla., 33580; **Samuel E. Lunden,** Assistant Secretary for California, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

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By the time these notes are published we will be together celebrating our long awaited 50th. **Oscar Horovitz** will have his cameras loaded and primed to picture **Randy Myer,** in top shape, ready for his fabulous tennis match, the 22ers and their lovely brides looking tanned and healthy, and **Parke Appel** welcoming the travelers who have come from everywhere for this momentous occasion.

To project events on this early April day is difficult as news items are very sparse. Many of you are leaving warm winter climates for your regular homes and bits and pieces of interesting events have been held for a later date. There will be an abundance of news for the next *Review* however. . . . In January your Secretary noted that if the estimated attendance of our 50th proves out, it will be the largest reunion of any Tech class, which prompts him to forecast "it was a *dandy,* wasn't it?" . . . Retired Colonel **Roger S. Walke,** U.S.A.F. has retired from the Virginia Electric and Power Co. He served in the 8th Air Force in the E.T.O. from 1943 to 1945. . . . **Allan W. Hastings** retired from Gulf States Utilities. He had been president of Stock Service, Inc., in Texas. . . . **William E. Cooper** has retired from the New York State Department of Public Works. He noted that this closed out a career of working out a better way of getting people from here to there, even if some were "by sin to folly led." He plans to be with us in Cambridge. . . . **William B. Elmer,** who holds about 50 U.S. and foreign patents is quoted in the *Union Leader* of Manchester, N.H. Bill's opinions are always worth special thought.

I am looking forward to seeing Dale Spoor, George Dandrow, Fearing Pratt, Yard Chittick, Don Carpenter, Bob Tonon and all those who have been so active in our behalf. We will be the featured class at Commencement and Homecoming and I know we will enjoy our place in the sun during this happy celebration. . . . However some familiar faces will be missing from our gathering. In looking over old notes for the *Review* I found a picture of **Chet Greening** in a row boat and excerpts from a letter extolling his peaceful retirement on the shores of Long Island Sound. He made plans to be at the 50th but the September 1971 issue notes his passing. We will miss him. . . . **Dino Spalding, Gus Hemeon, Bill Bainbridge** our avid sportsman, and the rest of our stalwart group will be present in our thoughts. When these well planned, long awaited festivities are *fait accompli* we will be able to say, in the parlance of the day, "Out of sight man, out of sight!"

The address changes received this month are Mildred Allen, South Hadley, Mass; Edward A. Ash, Homestead, Fla.; Chih T. Chu, Hong Kong; William R. Frazer, East Falmouth, Mass.—**Whitworth Ferguson,** Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz,** Assistant Secretary, 31 Montrose St., Newton, Mass. 02158

23

Pete Pennypacker has sent us a letter from **Samuel L. Williams,** who, we trust will pardon our lifting some of his observations on the current scene. He writes: "I don't think anyone should get a cost of living raise. You can't win that way. The cost of living affects everyone but only the monopolies can get a raise. They say you must have some inflation to have low unemployment. Improvement in productivity should permit some deflation if all of it wouldn't be grabbed by the unions." We are inclined to agree in principle but of course practical politics rules out any such practical or reasonable approach. Also, we have seen very little of sweetness and light on the part of any major interest group, government, management or labor ever since last August when the Phase I all began.

From the *Hartford* (Conn.) *Courant* we learn that **Arthur R. Belyea** was recently presented with a citation scroll by the Board of Selectmen of Old Saybrook. The resolution proposed (and passed) noted Belyea's "full contribution of time, talent and physical efforts" in his voluntary work in solving regional solid waste disposal problems. It was stated that Belyea's work showed that "his investigations and reports were of the highest professional standards and an invaluable asset to our community and others interested in solid waste disposal." We note that "Gus" is the retired chief engineer of ConEd of N.Y. Congratulations "Gus" we applaud anyone associated with ConEd who has the fortitude to tackle problems of this nature. We are certain that unless new methods of dealing with our trash are found soon, the problems will continue to be more "offal."

From the I.E.E.E. 1972 *Intercon Guide,* we learn that **Robert H. Park** was the recipient of the Lamme Medal—"in recognition of his outstanding contributions to analysis of the transient behavior of a.c. machines and systems." . . . The first meeting of the 50th Reunion Committee, chaired by **Herbert L. Hayden,** was held on March 30 at the Marriott Motor Hotel in Newton, Mass., the headquarters of our 50th in June 1973. Attending were:

Horatio Bond, Charles Burke, Forrest Lange, Charles Mapes, "Pete" Pennypacker, Tom Rounds and Herb. By the time you read this you will have received Bulletin number 1 of the Reunion Committee. It was a good meeting and when we left we were imbued with enthusiasm toward the coming event. Class jackets and the Class History situations were discussed at some length. You will hear more of these items later.

We have had belated news of the death of **James C. Walton** on February 3, 1972. Jim was president of Chase-Walton Elastomers of Hudson, Mass. He was chairman of the Norumbega Council of Boy Scouts and had been former chairman of the Boston Archdiocesan Catholic Youth Organization Boy Scouts. He was also past president of the rubber division of the American Chemical Society. . . . We are also sorry to report the deaths of **Charles R. Bailey** of Lighthouse Point, Fla., on January 27, 1972, **Thomas H. Boyd** of Clifton, N.J., on February 12, 1972, **Hugh A. Corr** of West Springfield, Mass., on May 16, 1962, and **John V. Janes** of Clayton, Mo., on January 6, 1972. If anyone has further details, please let us know.

The following address changes are reported: Harold R. Bjerke, Osterhausgatan 16 18, Oslo, Norway; W. Gordon Hughes, 189 Elm St., So. Dartmouth, Mass., 02748; Laurence S. McLane. Apt. 1504, 999 Wilder Ave., Honolulu, Hawaii, 96822; Brigadier General Stewart E. Reimel, General Delivery, Sea Pines, Hilton Head, S.C., 29928; Mrs. Philip M. Stearns, 3433 No. Moorings Way, Miami, Fla., 33133; Frederick B. Stevens, 909 San Carlos Dr., Ft. Myers Beach, Fla., 33931; John C. Todd, 1419 Hilltop Dr., Mount Dora, Fla., 32757; Mrs. Stephen Webber, 1 Barnard Rd., Westmere, N.Y., 12203; J. Harvey Westren, 33 Glenrose Ave., Toronto, Ont., Canada; Archibald Williams, Jr., 309 Bay Lane, Centerville, Mass., 02632—**Thomas E. Rounds,** Secretary-Treasurer, 4 Deer Hill Dr., Danbury, Conn., 06810

24

With the thermometer crawling up from 24 degrees in Brookline, it is somewhat difficult to extrapolate to the June temperature when you will be reading this, probably after '72 Alumni Day. I have just completed a search of Chick Kane's files and my reaction is best expressed by Longfellow, "Lives of great men all remind us, we can make our lives sublime, and departing, leave behind us footprints on the sands of time." Our Class insurance program, Chick's unforgettable Class of 1924 newsletters, officers' and committees' planning and Reunion successes simply prove that we have the potential of making our projected 50th Reunion Gift a masterful triumph. This may be in the form of bequests, cash, securities and real estate, all of which at any time goes in the pot until June 3, 1974.

While the preceding is a major part of our 50th, there is the important social side, about which you must speak your piece immediately to Paul Cardinal or your Secretary. Where shall we gather, campus or otherwise? Tentative reservations have been made at Wentworth-By-The-Sea, Portsmouth, N.H., from May 28 thru June 1. There is controversy over the purchase and wearing of red jackets. How about double-knit sport shirts of appropriate colors? What for the ladies? Cardinal and gray panty-hose?

Ray Lehrer and Dot have kept us informed of their world-encircling safari, south of the equator this time, with three news letters. I have found them most interesting, not only because Ray writes well, but he has combined observations, experiences and history. They returned April 14, and after a period of acclimation to food and time will probably head for Pickwick Lodge, their Maine Garden of Eden. Copies of the letters are available upon request. . . . **Paul Cardinal** writes that he and **Pret Littlefield** spent three days on accounting for the First Florida Fiesta finances and "endless visitors." He does not say whether they were expressing gratitude for hospitality, were curious about the aftermath or wished to prolong the fun. Paul takes his Reunion Chairman's job seriously and although he could turn his problems over to computers, I suspect that he, too, realizes that they are not infallible and would "rather do it myself."

A picture in the *Naples Star* (Florida) shows a large banner hanging on **Pret Littlefield's** quarters. Clearly, there is a flying stork carrying a bundle, and the caption notes that Pret is a resident of the Commodore Club and flies a banner when a friend has a baby. Pret has reached the age of 70, so your scribe is completely mystified by the significance of this procedure. . . . **George Glennie** took advantage of the space on his Alumni Fund envelope to kindly invite me and any other '24 men to dig up turf on his fine Andover golf course. From experience, I warn all takers to be in very good condition when you challenge George. He and Hazel recently had lunch with **Myron Freeman** and his wife at the Sturbridge Inn. Duke seems to be retired and living in West Hartford, Conn. . . . **Walter Bagby** and Frances have written the Cardinals and Littlefields thanking them for such a fine time in Florida and the welcome opportunity to become better acquainted with classmates and wives. On their trip back to Bronxville, N.Y., via Washington, D.C. they visited retired friends and relatives. Walt played golf on March 18, so his locality must have missed the snow storm in Boston.

Although **Herb Stutman** was weaned from Tufts, he spent two years with us and has been actively interested in our Class progress. He can take further pride in his son, Dr. Leonard J. Stutman '48, head of the blood coagulation research lab, St. Vincent's Hospital, New York City, who was featured in the "Medicine" section of *Newsweek* of February 28, 1972. The doctor has Ford Foundation support on a project to determine whether the old practice of blood-letting can reduce heart attacks. His goal is to compare coronary rates among men with a hematocrit level maintained at 42 with those of higher red cell levels. If successful, we old codgers will not only live longer, but be permitted to donate to blood banks, for which there is a crying need. . . . At a recent Federal Trade Commission hearing in New York City on the housing shortage, **William H. Correale,** Professor at Polytechnic Institute of Brooklyn cited costs of materials as a serious barrier to new construction. Directly related are the 5,000 local codes, which should be replaced by a national uniform building code. Bill says that flexibility can be provided by local enforcement.

Frank Shaw, our venerable anti-troglodyte Class Agent, is helping Uncle Sam by marketing his Cape Cod logger (a fireplace tool), but answers my pleas for broader class news: (a) an insert or return post card in each issue of the *Review;* (b) a half-tone small picture, full face, of the Class amanuensis heading the column. The theory is that the writer is talking directly to the reader, thereby exciting the endocrine glands and shooting hormones through the system, thus forcing the reader to do something. He omits saying to do what! . . . The Board of Directors of American Savings and Loan Association of Florida has been honored with the addition of **Gordon Y. Billard** to its roster. He is a prominent investment banker and partner in the Wall Street firm of Drysdale and Co. He is a Director of the Mulford Corp., and the Mulford Foundation and a Trustee of the Gordon Y. Billard Foundation. He maintains a residence in Bal Harbour, Fla.—**Russell W. Ambach,** Secretary, 135 Aspinwall Ave., Brookline, Mass. 02146

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Archer M. Nickerson, Jr., was made a life member of the Society of Naval Architects and Marine Engineers, together with other coauthors, for his contribution to the textbook on marine engineering recently published by the Society. **Garvin Drew** (Chink) was the presiding officer and moderator of the morning program of an alumni seminar on the subject of "Marketing and Product Development" conducted in Los Angeles. A letter from **Masaru Kametani** from Japan indicates if plans develop he may be coming to Boston and M.I.T. this year. We hope that this will coincide with Alumni Days in June when most of us will be around to say "Hello" to him.

Arthur W. Paulson passed on at Kennebunkport, Me., December 1, 1971. Arthur retired after 39 years of service as Chief Engineer, Engineering Division, of the Otis Elevator Co. After working in the New York Engineering Division from 1926-1942, he was named works engineer at Harrison. In 1945 he was appointed engineering supervisor in New York. He became assistant chief engineer in 1948 and chief engineer in 1949.—**E. Willard Gardiner** (Will), Secretary, 53 Foster St., Cambridge, Mass. 02138

26

This mid-April Sunday morning is cold, foggy and dreary at Pigeon Cove so we have forsaken the sea for the lower level study with a pleasant glow coming from

the corner fireplace. Having just wound the banjo, cuckoo and grandfather's clocks our thoughts associate with classmate, **Thomas D. Green,** our '26 expert on clocks. Last June at Reunion I mentioned to Tom an interest in a type of clock classified under the name Lyre. Believe it or not, at breakfast Sunday, Tom said he had found a genuine Willard Lyre clock in the Pleasant Bay Antique Shop. We took a look, but at 15 hundred bucks, we didn't buy. Instead we reproduced the clock by our arborlite process which had been the idea in the first place. Next our grandfather's clock began to act up and we wrote Tom about the symptoms. By return mail came a three-page explanation of what to do about it and the hazards. We decided the hazards were too great and await a visit from Tom enroute to Maine.

A recent letter from our class president, **Dave Shepard,** brings us up to date on his current major activity as board chairman of the Carnegie Corp., of New York. Dave says, "This is a very interesting job with an outfit of which I have been a trustee since 1962. Of course, I shall not be in the chairman's post very long because I shall reach the mandatory retirement age in only a little over two years. But in the meantime the association with interesting people, working on interesting problems is a very attractive one. All the best!" Guess the Carnegie Corp., must have a retirement age of 70 since in about a couple of years, that is where most of us will be.

With our 45th reunion just one year behind us, plans for our 50th are moving rapidly. As we have already reported, **Don Cunningham** has accepted the chairmanship and although he is on a Mediterrean trip, much spade work was accomplished before he left. The 50th is quite a wing-ding. It requires our active participation (in red jackets!) at the commencement exercises on Friday and the Alumni Day activities on Monday. That still leaves the conventional reunion weekend of Friday night through Sunday noon to do as we always have—or try to! There are several alternatives for the committee and they are being approached by seasoned reunion organizers who know the desires of '26 people. An additional reason for nailing things down is that 1976 commemorates the 200th anniversary of the good old U.S.A., so we will be competing for facilities, but don't worry, we have a good committee.

Jack Kelly, '43, has kindly brought us up to date on classmate, **Gifford H. Symonds**. Giff retired from Esso Standard Oil Co., in 1960 where his activity was in operations research, an activity he has since pursued at Case Institute, the University of Finland and currently at the University of California. Even more recently he has visited Universities all over Europe. Giff said in a recent letter, "The main trouble I have is that it is too easy to work too hard." To us this sounds like an excellent formula for enjoying life. So Until July—Cheerio.—**George Warren Smith,** Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

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By the time you read these notes, the 45th reunion will have come and gone, but because of the logistics of the publication process, the story will have to wait for a later issue.

You will notice a new signature at the end of these notes. After 30 years in the job, **Joe Harris** has decided that he has done his share, and it is difficult to argue with him. Over the years, the 1927 notes have been among the most faithful, most complete, and most gracefully written—if, indeed, not the very best of any appearing in the *Review*. Joe will be a very hard act to follow. Joe has no lack of activities to fill his time. He works as a SCORE counsellor, a voluntary activity of the Small Business Administration, in addition to his hobbies of oil painting and the study of antique furniture. Both Joe and Anne look pretty youthful for grandparents.

Bob Bonnar has a different idea of retirement, but then, his retirement is more recent. He spends an hour or two watching the quotation board at the broker's in the morning, goes to the golf club for lunch, and then plays cards or golf, depending on the weather, for the afternoon. He denies any inclination to find a regular activity, but I am betting that he will change his mind before too long.

I was intrigued by the thought of *dolce far niente* when I retired from Standard Brands last August, and I thought I would try it. By Thanksgiving, it had become too cold to work outdoors, and instead of loafing, I was being pressed to take on all kinds of volunteer jobs because "you have lots of time, now that you've retired." Just at that point, I was offered a job in the Finance Department of the City of New Rochelle—15 minutes from home, with no commuting. It is my first experience as a bureaucrat since War Production Board days, and in a field quite different from anything I have done before. I feel as if I am going back to school, and I enjoy it.

The reunion mailings turned up reports of the deaths of three classmates: **Ronnoc H. Connor** died this past January. He had been living in Barrington, Ill. . . . We have received word of the death of **Carl Sydenstricker** in Cleveland. . . . **Ed Dobbins'** wife writes that he died of a heart attack in Roanoke, Va., on February 5, 1972. We have had no recent word from these three, and have no details.

Selim O. Lunden reports that he retired on March 1 from the Connecticut Department of Transportation. . . . **Sam Auchincloss** retired on May 1 as vice chairman of A.M.P. Inc., but is continuing as a director and part-time consultant. He has sold his home in Pennsylvania, and tells us that he will be taking the "Whale Tail" on cruises down east during July and August.

Your new Secretary hopes that all members of the Class of 1927 will help him keep up the standards Joe Harris has set for these notes. Let me hear what you are doing. We are still looking for the first 1927 great-grandchild.—**Joseph H. Melhado,** Secretary, 24 Rodney Rd., Scarsdale, N.Y. 10583

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We were very pleased to receive a full and informative letter from **George Mangurian.** After retirement from Northrup/Nortronics in February 1971 as vice president in the Electromechanical Division, George completed two major consulting assignments with the company. Now he and Peggy are planning to build a home in Madison, Conn. They were expecting to leave Los Angeles on April 1 after living there 22 years. We were sorry to learn from George that his youngest son, George, was killed last May in an automobile accident near their home. This son, unmarried, was interested in formula car racing. He and George had just started a business in race car parts and service; everything looked so promising. The oldest son, David, is a free lance journalist (master's in journalism from Columbia) and has been in Central and South America the last four years. He is married to a beautiful Ecuadorian girl. They too are planning to live in the eastern states. The middle son, Robert, is an architect in New York City. . . . Last summer George and Peggy stayed with **Hal Porter** for a few days at Hal's place in Wilton, Conn. . . . More recently **George Palo** visited the Mangurians in L.A. Like many other classmates George is looking forward to the 45th next year at Bald Peak.

Bill Kirk is still active in the investment business as vice chairman of the board, John P. Chase, Inc., and president and director of several investment funds.

Early in March five of us gathered at the M.I.T. Alumni Association Office to spend an evening on telephones talking to classmates about the reunion and the Alumni Fund. The group consisted of **Jim Donovan, Carney Goldberg, Dave Rubin, Gus Solomons,** and **Walter Smith.** It was an interesting session and the responses were very cordial. Out of these telephone calls came the following news items: **Roland Earle** is still developing new products for his own company. His latest achievement is a patented aerosol waffle, pancake or crepe mix which requires no refrigeration. . . . **Charlie Haberstroh** is now fully retired but his wife, Anastasia, is still teaching (third grade). . . . **Bob Carder** says he is living in a rural area and that he is something of an historian. Several years ago he did some traveling in Europe. . . . **Herb Dayton** reported that he is doing no hard work. He is treasurer of his church and enjoys meeting people of all kinds. He was generous in his response and expressed appreciation for being called.

Al Beitzell is still leading a very busy life. He has done a good amount of traveling, including a trip to Spain. His son Robert, whose field is diplomatic history, is about to publish a book. . . . **Ralph Boeck** is a professor of civil engineering at Marquette University and does consulting work in addition. He has no plans for retirement. . . . **Bob Tucker** and his wife are retired and living on a small farm in Vickery, Ohio. We are sorry to learn that his son is incapacitated. Bob says that he always reads the *Review* and likes to hear about others of

the Class and of M.I.T. . . . **Phil Taylor** assured us that he and Iris will drive to Bald Peak next year to attend the reunion. . . . **John Robinson** and his wife both talked on the phone. They too are looking forward to the 45th. . . . **Gil Ackerman** says he is enjoying life and gets in lots of travel and golf.

In a brief note, **Eugene Boehne** says that he has been retired since July, 1970 but is still keeping very busy. He has given his hobby talk, "Nature, Art and Arithmetic" over 400 times in the U.S., Canada, and Mexico. Now he expects to have it in book form in 1973. He is planning to make his 25th trip to Europe this summer on business and will visit Cairo as well. We are sorry to learn that his wife died in December of last year. They had a delightful three-week trip to Australia and Fiji in 1969. Eugene was professor of electrical engineering at the Institute from 1947 to 1960 and in charge of Course VI-A.

A news clipping from the Cambridge *Chronicle-Sun* of March 23, 1972 carries a picture of **Gustave M. Solomons** as he was sworn into office as a new member of the Board of Managers of the Massachusetts Eye and Ear Infirmary. The Oath was administered by Governor Francis Sargent, '39. In this new capacity, Gus, with 13 other board members, will guide the governance of that famous hospital. Gus has been very active and prominent in civic affairs for many years. He served ten years on the Cambridge School Committee with two years as vice chairman. He is a member of the executive board of the Cambridge Council, Boy Scouts of America, a member of the Corporation of Mount Auburn Hospital, Cambridge, a board member of the Cambridge Red Cross and of the Joint Agency Division for the Massachusetts Bay United Fund and Community Services. He is a trustee of one bank and on the advisory committee of another. He is a member of N.A.A.C.P., a thirty-third degree Prince Hall Mason and Deputy for Massachusetts of the United Supreme Council 33 degree. Wife Olivia teaches school in Boston. One son, Gus, Jr., '61, is a choreographer and modern dancer of world renown. The other son, Noel, graduated cum laude from Harvard in 1966, received his M.D. in 1970 (also Harvard) and is now serving his residency at the University of Pennsylvania Hospitals in Philadelphia.

We regret to report that **George A. Flynn** died on December 16, 1971. The information was sent to us by his wife Laura. George graduated in Course XV and had his home in Speculator, N.Y.—**Walter J. Smith,** Secretary, 209 Waverly St., Arlington, Mass. 02174

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Butter King Cooper, Washington, D.C., states in his note that he has retired from government service (Oceanographer, GS-14, Naval ship Systems Command) after 21 years of service with the rank of Commander, U.S.N.R. (Retired). After April, 1972, he will be permanently located at Rocolet St., Tryon, N.C. 28782. He concludes, "Keep me informed about our 45th Class Reunion. Best regards to Frank Mead, John Rush and the rest of our classmates."

Neil C. Ross, Pleasant Hill, Calif., says that he took early retirement in 1964 as engineering manager for the Western Division of Dow Chemical Co. But soon after, he ventured into the hardware business, operating two successful stores on abbreviated schedules—working four days and taking two months off for vacation each year. Last year, he and his wife, Alice visited Hawaii. They have just moved in a newly built house on the edge of Cantra Costa Country Club, where they enjoy playing golf. . . . **Joseph L. Curran,** of Metaire, La., writes, "My retirement commenced on February 1, 1972. I have no plans at present for professional work but plan to pursue my many interests in Church, social golf, fishing, natural history and travel." . . . **Harold M. Weddle,** Pinerside, Ill., writes that he has been retired for two years and still living in the Chicago area, though he is now searching for a new location where he can play golf all year round. With this objective in mind, he and his wife Esther, took a motor trip last winter, as far west as L.A., and then south to Mexico. He concludes, "Have decided that Southern California has it all, and we plan to sell our home and locate in an area where the weather is good all year-round. This is after 41 years with Dewey and Almy Chemical Division of W.R. Grace—the last 25 years at the Chicago Plant."

Floyd W. Buck, Hamden, Conn., writes that he is thoroughly enjoying his retirement, spending summers in Massachusetts and winters in South Carolina. . . . **James C. Reddig,** Webster, N.Y., has retired from Eastman Kodak after 33 years of service. About retirement he says, "The big difference is escaping the morning and evening traffic rush. I still find myself adequately busy with past and present projects including Airport Advisory Committee, staff work for Civil Air Patrol, and with the return of spring, I expect to get back to flying again as an avocation." . . . While the Reddigs were visiting their grandchildren in Galveston, in January they had a reunion with Doris and **Bill Baumrucker** at Houston while on a N.A.S.A. tour.

A post card from **Wally Gale** tells of a fishing expedition that he and Joan are enjoying in New Zealand. He writes, "This is about as far as we can get on the southern tip of New Zealand. Joan and I have been trying our fishing luck and skill. Three days off the coast of Norther Island yielded no marlin but a 250-pound shark. Spent four days in real bush on lakes and rivers of Southern Alps—flying in. Mostly dry fly of the toughest sort. Some trout but lots of gorgeous scenery." . . . **Raymond H. Shriver,** of Bellwood, Pa., writes, "Short time prior to my wife's death, we flew to Europe and enjoyed an excellent bus tour. We left the group at Paris, and in a few days flew to Stuttgart. At nearby Sindelfinger, we picked up a Mercedes which we had previously ordered, and then drove 1849 miles, chiefly in beautiful and clean Germany. I have a son, now with I.B.M. and two grandchildren."

Bill Bowie, Slingerlands, N.Y., our Class Agent, has been awarded a certificate for outstanding effort in the 1971 Alumni Fund drive. . . . L.T.V. Aerospace Corp., of Dallas, Texas has announced the retirement of **Russ Clark,** Senior Vice President (technical) effective January 1, 1972. He will continue as a member of the board of directors and as a consultant to the company. Since 1969, Russ had provided engineering and technical guidance to all elements of the corporation. Russ had been recognized as one of the nation's top ranked aeronautical engineers and was closely involved in his more than 40 professional years with the design and production of aircraft.

Roger A. Sykes, Bethlehem, Pa., writes, "Since retiring late in 1968, we have finished a summer home at Lake Sunapee, N.H. Now we spend most of our summer there. Mary spends most of her time at church workshops, chasing auctions and following a button collection hobby. Since I know we will all wind up in the solid state, I thought I should learn something about it with the aid of a scope, soldering iron and bits and parts. Having fun trying out the results via amateur radio."

Sam Shaffer of Kirkside, Calif., writes "I am due to retire from the May Co., at the end of the year. I intend to play some golf and do a little financial consulting work. Sybel's and my health continue to be good, and we hope to get in a little traveling. The house the children grew up in, is not too big; it just accommodates the grandchildren—so we don't have to make a move at retirement time."

Some of you have inquired about **Hugh Hamilton**'s health. Your Secretary is happy to report that he recently paid a visit to Hugh and Helen at their winter home in Boca Raton, Fla., and found a great improvement in his condition. He no longer uses the wheelchair and is able to walk around the house unaided. His outlook on life is also very optimistic and his spirits are high. The Hamiltons would welcome any Twenty-Niner at their summer home in Durham, N.H.—**Karnig S. Dinjian,** Secretary, 6 Plaice Cove, Hampton, N.H. 03842

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On February 24, at a banquet in his honor, **Reg Bisson** received the Engineer of the Year Award of the New Hampshire Society of Professional Engineers. The report of this event in the *Laconia Evening Citizen,* describes a number of interesting highlights in his career, particularly during World War II when he was on active duty with the Army Corps of Engineers. During this period he served overseas with the North African Military Mission, was area engineer of an advance area and then commanding officer of the Levant Service Command. In the latter capacity he supervised the building of a general depot at the edge of the Sinai Desert, including a 1000-bed general hospital. In 1944 he was sent to the interior of China as district engineer, building air bases for the 14th Air Force. Later in that year he returned to the States as construction officer for the First Air Force with headquarters at Mitchell

Field. He was awarded the Legion of Merit for duty in the Middle East and has a combat star and service ribbons for three theatres of operations. He retired from the U.S. Army Reserve as a colonel in 1968. Reg is a charter member of the Associated General Contractors of New Hampshire, a trustee of the Lakes Region General Hospital, the Laconia Savings Bank and the Taylor Home for the Aged and a director of the Rotary Club and Chamber of Commerce in Laconia.

Joseph Kania reports that he retired last year as a partner and director, but doesn't say what he retired from and my records are blank on this point. In any event, he has been making annual trips abroad with the Vancouver Board of Trade Missions and will apparently continue to do so. Last year the Board visited Malaya, Singapore, Taiwan, the Philippines and South Korea. This year's itinerary includes Australia, Indonesia and Hong Kong. . . . **John Guinan** reports that he retired from Con Edison in October 1969, but didn't give any details as to his retirement activities. . . . **Arthur Griffith** retired as of May 1, 1971 as assistant manager of District Sales of Lukens Steel Co. He and his wife are planning to make a permanent move from their present home in Schenectady to either Virginia or one of the Carolinas. The Griffiths have two children: Virginia, who graduated from Smith, with a B.A., and Columbia with a M.A., is now married; and Arthur Jr., who graduated from Yale, attended N.Y.U. Law School and is now a stockbroker.

Win Hartford writes that since he moved to Charlotte, N.C., and started teaching at Belmont Abbey he and Mary have continued the community theater activities they found so enjoyable during preretirement in Syracuse. They have participated in productions of *Prime of Miss Jean Brodie, Babes in Toyland, Night Thoreau Spent in Jail, Inherit the Wind, Hadrian VII,* Moliere's *Miser* and a TV commercial.

We are sorry to report the receipt of a notice that **Tom Emery** died suddenly on November 25, 1971, of a cerebral hemorrhage. According to my records Tom was a self-employed accountant and tax counselor in Birmingham, Mich.

Changes of address: Mr. Ralph H. Wingle, 3800 Galt Ocean Dr., Fort Lauderdale, Fla.; Mr. Robert K. Whitten, Brookfield, Vt.—**Gordon K. Lister.** Secretary, 530 Fifth Avenue, New York, N. Y. 10036

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Minot R. Bridgham retired from the Metropolitan Life Insurance Company in April and he and Norma are planning to spend May, June and July on a transcontinental motor tour visiting friends and relatives in the U.S and Canada. Being uncertain that he will stay retired, Minot forwards us a resume detailing his activities since 1947 in the application of computer science to the insurance business. He will maintain his home at 12 Byron Ave., White Plains, N.Y. 10606. . . . **Russell S. Robinson** retired in August, 1971 but is keeping busier than ever with much more consulting than he had planned. He and his wife, Sylvia, have been traveling a good deal, visiting children who are established all over—France, California, Japan and Australia. He advises that if you keep your health after the kids are established—it's the life.

Dr. **Oscar T. Marzke** retired from the U.S. Steel Co., in February, where he has been Vice President of fundamental research since 1957. He was graduated from Michigan State in 1929 and received his Sc.D. degree from M.I.T. in 1932. He began employment with U.S. Steel in 1934. He went to the U.S. Naval Research Laboratory in 1946 and became director of research in 1956. While at this laboratory he played a major role in the reorganization of the laboratory and strengthening the capabilities of the metallurgical division. . . . **E. Harold Anderson** retired last October from the L. E. Myers Co., electrical contractor in Chicago and moved to Glenn, Mich., where he has been remodeling a summer cottage for year-round use. The Andersons are interested in Home Missions and they have been accepted as missionaries with the Galilean Baptist Mission at Grand Rapids. With a travel trailer they are helping new churches get started in Michigan and find life fuller and busier than ever in the Lord's service. They also recently took a tour of the Holy Land. . . . **Samuel E. Paul** is two-thirds through his three year residency in psychiatry at Camarillo State Hospital. He highly recommends a return to schooling at age 60 and has found it a most invigorating experience. . . . **Charles C. Wyatt** is presently residing in Hong Kong where he is directing the construction activities of M.K.W. International, Ltd., in Korea, Vietnam, India, Pakistan, Iraq, Turkey and Greece. He is president and owner of this subsidiary and the parent company.

We regret to report the death of **W. Otto Bussenius** of Chicago on July 15, 1971 and the death of **William A. Shaw** of Middleton, Mass., on October 13, 1970.—**Elwood W. Schafer,** Secretary, M.I.T., Rm. 13-2145 **James Harper,** Assistant Secretary, 2700 So. Grant St., Arlington, Va.

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President **Jim Turner** says that he had an ear operation in late fall, and was just getting stabilized as of December. He reports that the 40th Fund telethon, in early November, was manned by Bob White, Westy, George Stoll, Fred Murphy, Linc Ryder, Mal Mayer, and LeBurt Webster.

News from **Doug Stewart,** of Whittier, Calif., tells that he enjoyed a trip to Tahiti, where he was scuba diving with a group of enthusiasts of same.

Fred Murphy, bless him, comes through. He gives us a summer address on Cape Cod, available upon satisfaction of the usual requirements. Fred sees **Gene Robinson** once in a while, and Gene is still with United Aircraft in Hartford. It seems that Murphy family has stabilized at seven: the two oldest girls are married and have children; there will be three in college next year (71-2); the two youngest boys are in junior and senior high school which makes Fred the last '33 P.T.A. member. The situation is such as to allow the senior Murphys to take a long cruise, every spring by themselves. . . . a P.S. allows that **Dick Warner** and Mimi still enjoy their retirement in Falmouth.

Dayton Clewell says that the '33 news are the best of all, but admits that he seldom reads the others; . . . Dayton sees **Isabel Goodridge** every month or so, and says that she is in her usual good spirits. All three sons live near her, and are all doing quite well in business. Clewell son, Don, is an assistant professor at the University of Michigan Medical and Dental school, doing cancer research. So, Don will be able to spend a good part of the summer with Dayt and Jean at Lake Winnipesaukee, each year. Dayt deplores the lack of money for research in his chosen oil field, Mobil! . . . **George Henning** and his lovely Lucy took a Pacific trip spring of '71, as part of a spring meeting of the Chief Executive's Forum. George, as part of the Forum deal, was fortunate enough to meet government officials in every country they visited.

Beau Whitton is a confirmed grandfather. . . . From **Bill Harper,** we have a page and a half; good wife Bobbie has purchased an island, or a part, off the Mexican coast near Tampico, "Tamiahua", three hours from Houston, via air. William, never mind my detour via Houston, en route to Exeter; you detour via Chatham Bars Inn, come June 1973, and, bring Bobbie.

Ellis C. Littmann, 40th Reunion Fund Chairman, Class Estate Agent, etc. informs us that we are about two-thirds of the way to our goal of $660,000 which, it appears through the Alumni Association, to be almost exactly par for this annual course. A lot of this is due to the telethons. Ellis reports that he and Roz spent three weeks in Greece, Italy, and other parts of the big sea. Also, several trips to Boston, on Institute business, and regular visits to daughter, Susan, who is a student at Mt. Holyoke. Ellis and Roz have spent a little time in Florida this winter, but it was all business.

It appears that **Roger Congdon,** and **John Long** were to attend the Endicott House M.I.T. dinner, March 16, at which Dr. Paul Gray was to have been the principal speaker. . . . **Cal Mohr** says that Ellis Littmann has recently been involved in an executive shuffle in his firm, but he had no details. Ellis, if it is any of our business, we await with pleasure your added comments. Cal announces that he is to be chairman of a one-day symposium, in Chicago, sponsored by the local chapter of the Filtration Society.

Leona and I recently took a trip to Cypress gardens, Tallahassee, and, much longer, extended it to Pensacola, present home of Ruth and **Robert Timbie.** We stayed overnight and came back all along the Gulf Coast, thence to Ocala and home. We had a short visit to the Timbie home, saw a new camper trailer, Bob's pride and joy, and saw a few movie shorts of their trip to the Mexico City M.I.T. Club Fiesta. It was a real pleasure to visit with such old friends. Bob is a fellow mechanical, son of an Institute pro-

Ruth and Bob Timbie, '33, with Leona (Mrs. Warren) Henderson at a recent visit the Hendersons made to the Timbie home in Pensacola, Fla.

fessor of electrical engineering, and a friend for over 40 years. The above photo was taken on the occasion of our visit. The Timbies have a married daughter, with children, a son who lives less than 100 miles away, and another son just returned from Vietnam. Bob has been employed with the Chemstrand Division of Monsanto these many years, and is a real practicing engineer, presently assigned to special projects.

Now, there is room for one more mechanical, **William Baur.** Bill attended a Central Florida M.I.T. Club meeting late in 1971, at Clearwater. It was the usual year end meeting, with present and prospective students attending, with the students running a sort of panel of "Modern M.I.T." Bill's remarks are to the point. He believes that the "silent majority" of students are about what they should be; serious workmen, not too much In sympathy with the boisterous few who elect themselves leaders. Bill hopes to attend Alumni Day in June.

As for Leona and me, we had the pleasure of visiting the gallery of the Florida Senate, of which son, Warren S., is minority leader. It was also arranged for us to meet Governor Askew, and have our pictures taken with him in his office. . . . Two cards from Petey and **Dyer Potter,** who stayed in Juno Beach for a couple of weeks and then took off for a stay in the Bahamas. Dyer is retired from the Connecticut Highway Department.

Now, a card from **Mal Mayer,** written from New Guinea, as part of their Australian trip. Mal saw no classmates in the South Pacific, or at least none that he recognized. . . . A press release by the Chrysler Corp., announcing a contract with Steam Engine Systems, Inc., of Newton, Mass. refers to our own **Dick Morse.** S.E.S. will develop, assemble, and test a complete first-prototype (reciprocal) engine system with capability to power a standard six-passenger automobile. Great stuff, Dick. From still another irrepressible, **Athelstan Spilhaus,** comes a press release of six printed pages, entitled, "Ecolibrium", a coined word by Ath meaning, "balance in our earthly home." There is just no way of condensing this bit, so I offer to xerox it for anyone who asks, accompanied by a personal biography bit of the asker. We have a few address changes, available under the usual terms: Werner Bachli, Robert (Bob) Dillon, Arnold Fedde, Benjamin Hiatt, Donald A. Ross. You fellas may read this just about Alumni Day time. Leona and I will be there.

One more parting shot: remember that your 40th Reunion is just one year away when you read these immortal lines. Please mark your calendar, now, and don't look around for something that you might prefer in 1973. There is only one 40th, and we wish to make it the best ever. Many of us won't make the 50th on account of non-availability, so this might well be the big one. So, starting right now, I will sign my own name as sponsor, and also the name and address of the 40th Reunion Chairman, **Clarence R. Westaway,** 247 Commonwealth Ave., Boston, Mass. 02116. Write Westy right away, as soon as you have decided you will make it for sure.—**Warren J. Henderson,** Secretary, Fort Rock Farm, Drawer H, Exeter, N.H. 03833

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These notes are written in different surroundings than usual—we are visiting Mora and **Eric Isbister** in Charlottesville, Va. We had planned this trip for early April so that we could see two spring flowerings—here and then latter back on Cape Cod. When the time came to start we were more than ready—28 degree temperatures. But we've been somewhat foxed; they've had the same chilly weather and all the flowering foliage has been held back. We made a brief run down to Greensboro, N.C., and were able to see dogwood and red bud beginning to open up. On the way back to Charlottesville we covered about 50 miles of the Blue Ridge Parkway. There was the customary haze that cuts down the long visibility but the views when we stopped at some of the overlooks were really spectacular. Those are the only ones the driver gets to see—on that drive, you keep your eyes on the road—or else!

Eric is back now in engineering work here as manager of Systems Engineering at the Sperry Marine Systems Division, and is doing more travelling than when he was in marketing. . . . I have another installment in the travelog from our peripatetic Assistant Secretary, **George Bull.** He has been keeping his promise to send me a monthly account of his round-the-world trip with Mary Elizabeth. This month's letter, dated March, covers some of the more exotic areas and I'm going to include more of his notes.

George writes, "The first of March found us arriving in Bangkok which we found very full of auto traffic, particularly after Burma. The emerald temple and the canals are well known.

"Bali was much as one would expect, however, the upper half of the women is now 'covered by cloth and by laws' (George sounds disappointed—is he turning into a 'dirty old man'?) After a few days in Ceylon with a train trip to the old capital Kandy, 2000 feet up, we went to Kabul, Afghanistan. One cannot fly between India and Pakistan. From Kabul we drove through the Khyber Pass to Peshawar in Pakistan. The pass is not one shallow cut in a range. It is an area about 30 miles in length. Much passport checking and no photographing. It has a wild and rugged terrain, with many forts and one can understand the problems the British had in their Northwest Frontier provinces. One hundred miles north of Peshawar, in the province of Swat, surrounded by the Hindu Kush mountains, we found a place where as yet U.S. prices had not penetrated—full pension at $9 a day.

"With my interest in the oil business I am sorry I couldn't get up the west coast to Baku so we contented ourselves with a trip down, that was an end run around the mountains that border the edge of the Caspian and are the reason that even visitors to Teheran by air do not usually see the Caspian Sea. We stayed overnight in Ramsar in a hotel next to one of the Shah's palaces. He was away but I was politely told I could not photograph the gate. The return to Teheran was a spectacular ride over an 8000 foot pass. Thus endeth the March letter."

After such a pleasant account I am sorry to have to report the loss of another member of the Class. **Wilbur R. Nordos** died in Delmar, N.Y., on March 14. I have no other information. On behalf of all the Class I would offer our sympathy and condolences to Mrs. Nordos.—**Robert M. Franklin,** Secretary, Satucket Rd., Brewster, Mass. 02631; **George G. Bull,** Assistant Secretary, 4961 Allan Rd., Washington, D.C. 20016

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Dave Buckwalter wrote me a nice letter from his home in San Manuel, Ariz., and it was put in the wrong file, but here it is finally: "I must admit that I am one of the guilty from the Class of '35 who have done little to maintain the tie that binds one with his old classmates. If golf will strengthen the thread, I shall be glad to try it. Most of my spare time has been spent in the hills fishing, hiking, skiing and picture taking. I had always believed there would be time for golf when I was too old for the strenuous activities. Now that the time has come during the last couple of years I find that golf seems unconquerable, at least for a weekend player. My handicap of 24 testifies to this. We play in Tucson, which is 40 miles from San Manuel; we are 125 miles from Phoenix. I have been successful in promoting a golf club in San Manuel, a nine hole course completed last August. It will be a nice facility for this mining

town of 5000 people. When you are in Arizona, I will be pleased to show you one of the more important installations which supplies the copper for the electronics industry. We are presently engaged in spending some 250 million dollars expanding this operation. This work is nearly completed but we must now embark on another 50 million dollar expenditure to eliminate the sulfur dioxide from our stacks. It is my duty to shepherd the engineering and construction of this work. Perhaps we might even get out for a game of golf."

Doreen's work on the class notes in April produced a delightful message from **Frances Loewenstein** in Greensboro, N.C., and another letter from Stocky at Dartmouth which are reproduced below: "Sorry to see by the notes that you have been under the weather. As I see it, it's a great reason for you to play all the golf you like. How lucky can you be? Also at some juncture, you and Doreen must do it in our 'moderate' climate—total rain and a bit of snow for the golf tournament and four inches of snow last week after bulbs and shrubs blooming." Thank you, Frances, it was nice to hear from you. Doreen and I will try to arrange it. . . . From **Walter Stockmayer:** "Having just read in the *Review* about your illness, I hasten to dash off a message of good cheer from Sylvia and me. You are by now probably well on the recovery road. I hope all is comfortable and that you have plenty of good reading and listening material, plus good friends to visit. Sabbatical plans for the fall term are firmed up and we will definitely be in the industrial Limburg corner of Holland for two months or so, at the Dutch State mines, where a Dutch friend of mine and I will try to write a small book on the thermodynamics of polymer solutions (whatever they are!) Before then we'll do some vacationing in Scandinavia and Switzerland (latter my prime favorite). I look forward to hearing that you have again stepped onto the course and won the Class Championship in golf.

"My own ailment is minor: degenerative joint disease in the right shoulder, causing a nerve pinch with loss of feeling in several fingers if too much weight is put on that shoulder. So when I hike I may not carry a pack with a right shoulder-strap; we have rigged up a fancy gear with chest straps, etc. So, last week I was on Jefferson and Adams on about nine feet of snow in places. Your Doreen deserves a great cheer from your classmates (and better from you) for keeping the column alive. Our best to her." Many thanks for writing again, Stocky—she does, did and got it!

The committee on Election Procedure appointed by **Bob Forster** in the late fall 1970 has submitted its final report. This committee consisted of **Jack Colby,** Chairman, **Ned Collins, Wes Loomis, Ham Dow, Walt Stockmayer** and **Ed Taubman.** The time and effort expended by the committee is appreciated and their suggestions and recommendations will be implimented in the near future.

Finally, some interesting address changes: Guy Haines is now located in Bucks, England, 13 Cressington Pl., Bourne End. Dick Bailey has apparently sold his home overlooking the golf course and moved to an apartment. He is now at 840 Teasel Dr., Apt. C-7, Kingsport, Tenn.

The 12th Annual Class Golf Tournament is under way and first round results may not be known in time for the next issue, but we'll keep you posted.—**Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

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Through Henry Lippitt I have received a clipping from the Eastman Kodak "house organ" with a picture and story of the months which Betsy and **Harry Essley** spent on the *S.S. Hope.* Harry as the ship's medical maintenance engineer found himself "flooded with work." "I was responsible for maintaining all hospital equipment such as gas analyzers, isotope scanners, and x-ray and anesthesia instruments, but I also ended up servicing electric typewriters, copy machines and the staff's tape recorders and sewing machines." The Essleys were able to explore nearby areas on weekends and spent one week of vacation touring Jamaica and another in Guatemala. Harry and Betsy returned to Rochester just before Thanksgiving. After a period of catching up on family and friends they hope to render similar service in some other part of the world. Meanwhile they have been skiing in Switzerland and expect to be in Greece about the time these notes are published.

The American Chemical Society met in Boston in April. Your Secretary served on the Northeastern Section Committee as co-chairman of the General Interest Program. Among many friends attending was **Charlie Saffer** whom I had not seen since we graduated. His company, the Witco Chemical Co., was sponsoring one of the awards. We compared notes on the whereabouts of other Course Fivers and regretted that more were not present.

Robert Leventhal of Newton died in Boston on March 8. With his brother he founded the Beacon Construction Co., of Allston which owned and developed the Center Plaza Office Building in Boston's Government Center, the Wellesley Office Park, Worcester Center and a Syracuse Office Building in addition to more than 2000 multi-family housing units. He had been a member of the Special Task Force for Mass Transportation, appointed by Governor Sargent and was a trustee of the Belmont Hill School, Concord Square Trust and Boston's Old City Hall preservation group. He is survived by his wife, Eleanor, three sons, his mother, two brothers and a sister. To his family the class extends its sincere sympathy.

A reminder that your Secretary will be most happy to see as many of you as can arrange it for a '36 picnic at West Hartland, Conn., on Saturday, June 24, from 10 a.m. on. Swimming, sailing, and conviviality will be the order of the day. Informality the password. If you haven't already indicated that you will come, just call up. I will plan to be home most of the two days preceding. The telephone is (203) 379-3807.—**Alice H. Kimball,** Secretary, P.O. Box 31, West Hartland, Conn. 06091 or Apt. 8-6C, 100 Memorial Dr., Cambridge, Mass. 02142

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Our class has had their 35th reunion at Chatham Bars Inn on Cape Cod. A list of those attending plus the results of the class questionnaire will appear in the next issue of the class notes. **Sydney B. Karofsky,** president-treasurer of Northeastern Wallpaper Corp., and Northeastern Wallcoverings, Inc., both of Boston and Hartford has been elected a member of the Board of Directors of Commonwealth Bank and Trust Co., Boston, Mass. . . . **Charlie Dierksmier** and his wife Mary, celebrated their 25th wedding anniversary in May.

It is with regret that I report the death of **Stephen M. MacNeille,** 3 Granuaile Rd., Southboro, Maine, on March 23, 1972.—**Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Curtiss Powell,** Assistant Secretary, Rm. 5-325, M.I.T., Cambridge Mass. 02142; **Jerome Salny,** Assistant Secretary, Egbert Hill, Morristown, N.J.

38

One of the delights of being a Class Secretary is that occasionally you hear from old friends. After approximately 25 years of silence I got a letter from **Harry Hollander.** Harry winters at P.O. Box 283, Longboat Key, Fla., 33548 and moves up to Truro on Cape Cod in May where he has built a house by the Bay. He really wrote me to promote his new book called *Plastics for the Artist and Craftsman* published by Watson-Guptill. The reader is shown step-by-step how to mix, prepare and use a wide variety of plastics systems. Harry, how about a review copy?

Al Wilson was named a trustee of the Massachusetts Bible Society last March which was duly recorded in a handsome photograph in the *Cambridge Chronicle* . . . **John J. Perkins** writes "Senior Mechanical Engineer, Gilbert Associates. Just moved to Reading, Pa., area. Two sons married, another in college. Two daughters in high school." . . . **J. A. Crichton** states "President of own company, Crichton and Co., Dallas, Texas, a management and consulting firm in petroleum, natural gas and minerals. Last year our company, Arabian Shield Development Co., was awarded first mineral exploration licenses in Saudi Arabia!"

A communique from **Don Severance** states first that he saw Henri and **Harold Strauss** at Los Angeles and, as a matter of fact, had dinner with them in Pasadena. Don, incidentally came up with a great idea. As you know if you have read this column faithfully we have a 35th reunion coming up next year. Don suggests that it would be appropriate to have a pre-35th reunion at the 25th Annual Fiesta of the M.I.T. Club of Mexico City next March. Accordingly, I am trying to block off the time and suggest that some of you join with us.—**A. L. Bruneau,** Jr., Class Secretary, Hurdman and Cranstoun, Penney and Co., 150 Broadway, New York, N.Y. 10005

40

In keeping with the streamlining of the *Tech Review,* this column will be brief. **Jerry McAfee** has been voted a Fellow of the American Institute of Chemical Engineers on December 31, 1971. . . . **Karl Fetters** has retired from his position as vice president of technical services for Youngstown Sheet and Tube Co. He will still act as consultant for Youngstown Sheet. Karl is widely known throughout the steel industry, both in America and abroad, and has received recognition and numerous honors in other areas of the engineering community. He has served as president of the American Institute of Mining, Metallurgical and Petroleum Engineers, is a Fellow Grade member of the American Society for Metals, a Fellow of The Metallurgical Society of AIME, and was the first Ohioan and the first steel industry engineer elected to the National Academy of Engineering. He has been chairman of the General Research Committee of the American Iron and Steel Institute, a director of American Standards Association, a member of iron and steel professional groups in Great Britain, Scotland and Germany, and the author of scores of scientific and technical papers. Karl was honored by the Mahoning Valley Technical Societies Council in its Outstanding Persons awards, and was chosen the first lecturer in the Marcus A. Grossman lecture series sponsored by the Mahoning Valley chapter of A.S.M.

A native of Alliance, Ohio, he attended public schools there and earned a bachelor of science degree in metallurgical engineering at what is now Carnegie-Mellon University in Pittsburgh. He later became an Open Hearth Fellow at Tech, from which he received a doctor of science degree in 1940. Karl returned to Carnegie as assistant professor and staff member of the Metals Research Laboratory. He then returned to Youngstown Sheet and Tube Co. as special metallurgical engineer for the operating vice president, assistant to the vice president of operations, assistant vice president of operations, and in 1959 he was elected vice president in charge of the research and development department. Under his general direction, the company constructed its present modern technical center near the general offices in Boardman. Since early 1971, he had the title of vice president—technical services. Karl visited the iron and steel industries in many European countries and in Japan, and helped Youngstown negotiate a contract with a Japanese steel company to produce a chromium plated steel for use by the can industry.

Karl is an expert photographer, a ham radio operator with contacts all over the world and a rig the envy of most "hams", and an experienced and skillful boatsman. He has taught courses in seamanship, piloting and boating safety. Karl and Mrs. Fetters live at 2 Oak Dr., Poland, Ohio. They have five grown children.

Garrett Sloan pens "I have been director of the Department of Water and Sewers, City of Miami since 1966. We have the large central water system serving 70 per cent of Dade county, and a large sewage disposal system. The rapid growth, water shortages, pressure for better sewage treatment and changing governmental desires keep one in motion."—Write **Al Guttag,** Secretary, Cushman, Darby and Cushman, 1801 K Street, N.W., Washington, D.C. 20006

41

The Class of '41 figured prominently in the news this month, with releases received coast to coast. . . . From the Hayden Planetarium we learn that the final funds have been received to complete the West Wing Campaign, with an anonymous donor pledging $450,000. This represented the greatest single fund raising effort in the 142-year history of the Museum, with 15-million dollars having been allocated. The newsletter to Friends of the Museum of Science is signed by none other than **D. Reid Weedon, Jr.,** President, Class of '41, naturally. . . . The monthly newsletter of the M.I.T. Department of Civil Engineering features five members of the Class, with news that Robert Whitman is serving as coordinator for the National Science Foundation sponsored research project on "Optimum Seismic Protection for New Building Construction in Eastern Metropolitan Areas," in the new earthquake study. Twenty faculty members and students are involved in various phases of the study, with the history of earthquake occurrence in the Boston Area, led by Professor C. Allin Cornell and the study of theoretical predictions of building response to damage to fill gaps in the empirical data being done by **John M. Biggs.** Your Secretary refrains from mentioning this as being earth-shaking news.

Professor **David H. Marks,** was in Buenos Aires in March in connection with the Argentina Project of Water Resources and Hydrodynamics Division. . . . A note from **Frederick Kunreuther** announces his resignation from Shell Oil as manager of process engineering after 29 years, to continue in his own consulting firm founded in the fall of 1970 in New York at 1270 Sixth Ave. The family remains in Scarsdale. . . . **Calvin MacCrackin** writes that he has just won his third straight National Senior Squash title in February in Detroit, which was his eighth national title. His company, Calmac Manufacturing Corp., of Englewood, N.J., is manufacturing and installing a new type of patented portable ice skating rink invented by Cal and called the Icemat. The rink rolls out like carpeting on any surface and is then sprayed with water to build up ice. Maybe we could use one of these on Nantucket, and your Secretary would win an award for something other than the sedentary existence he now leads.

North Carolina State University at Raleigh issued invitations in March to the dedication of The Swann Memorial Library of Chemistry in honor of Ralph C. Swann, '41, who is now deceased. A fine tribute to Ralph and a contribution to continuing his work. . . . When I said news from coast to coast I should have said international coasts to coasts, with a note from **Robert Blake** describing his visit to Kabul, Afghanistan to see old friends there and visit the airline he founded. He says it is now completely Afghanized in personnel and management, highly professional in operation, runs on time, and makes a profit. Someone should confer with our major airlines for an assist in organizing such an operation. Just being on time and profitable would be an improvement. Robert says one can now fly direct to Kabul from Paris, London or Frankfurt without changing planes, on this successful transport system. . . . **Robert Butman** was chosen Chairman of the Concord-Carlisle Regional District School Committee and it is rewarding to see so many members of the Class performing such valuable community functions.

Nantucket has now had its April snow storm, and Spring is obviously here. During this summer when some of you visit our "Yesterday's Island," be sure and drop by 22 Broad St., and say "hello."—**Michael Driscoll,** Secretary, P.O. Box 1044, Nantucket, Mass.

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A note was received from **Curt Smith** recently which saddened our hearts. It said that **E. Charlton** ("Charlie") **Crocker** had died in February after a brief illness. Dick Feingold wrote to Phyllis Crocker on behalf of our classmates. Charlie, Curt, yours truly and a bunch of others were in the "special" Course X-C group that was convened in Summer, 1942 to get a three-session chemical engineering practice school under our belts before graduation. I was grateful to Charlie in those days; he was one of the few fellows who knew what he was doing in organic chemistry—and why things turned out as they did! We will miss you, Good Friend!

A card arrived from **Harold Rosoff** with a brief account: "Joined Greyhound Food Management Co., in 1969 as Vice President of Research and Engineering. In 1971, moved to corporate headquarters in Phoenix as a Vice President of Greyhound Corp., with responsibilities for manufacturing activities of Armour Food Co., Armour-Dial Corp., and Greyhound Food Management Corp." Your card arrived just in time, Hal; **Jim Hoey,** Class President, has been looking for a good man to put in charge of chow for our 30th Reunion! What's that, you're being transferred to China? . . . **James P. Craft, Jr.,** comes through with some news-in-brief: "After heading the Contingency Plans Branch of the Joint Chiefs of Staff, I left the navy after 30 years and got my Ph.D. degree from the University of Pennsylvania in International Relations. I went to Ursinus College to teach and write my dissertation, completed in 1969; I am now assistant dean of this college. Last summer I spent eight weeks of postdoctoral work at the University of Michigan where I was researching the application of cybernetic theory to national defense decision-making."

Charles E. Burnham only used half an envelope to tell us, "Starting a new company in the Republic of Ireland. Will be

President and Managing Director of Draper-Erin, Dock Road, Limerick." It's enuff to warm my heart, Charles. . . . I get to County Cork myself to do business with Winn-Technology. I'll drink a pint with ya in the 'Olde Country' the next time through! . . . Flash! The Assistant Secretary actually received a letter from a classmate! It was easy! I simply told him I wouldn't print the news of his promotion unless. . . . So, thanks **B. V. Hettich** and congratulations on the move to manager of research planning in the Technical Department of F.M.C.'s American Viscose Division in Philadelphia. In his personal note, Rich Hettich reports, "Charlotte and I are blessed with two wonderful children. Our son, Jan, is a sophomore at Princeton where he plans to major in math. Our daughter, Kay, plans to continue her piano and music studies; next year she will be spending a year abroad under a Rotary Scholarship to complete high school. Charlotte devotes much of her time to American Field Service work here in Media, Penn., where she is president of the local A.F.S. chapter. I am an Elder at our church and much involved in the programs there. On April 12, I was on the program at the American Chemical Society's meeting in Boston on the subject of Textile Flammability Standards—Their Impact on Fiber and Chemical Markets; my part covered cellulose fibers." Thanks, friend of Course X-C days; you've come a long way since those coke oven tests at the steel mill in Lackawanna, N.Y., circa Winter, 1942-43; at least you're working *inside* now!

Every once in a while, we get a "quickie" which floats in here with an ancient post-mark on it. There are two "oldies" this month. The first is from **Gus Root** as of about November '71 who said: "My international family keeps us guessing. After a year in Switzerland and a summer in Ghana, my daughter Karen is heading home by hitch-hiking across the Sahara. An African and a Mexican boy keep our house full as our own kids are off adventuring. I'm into my third profession; after 20 years as an engineer, I'm now Associate Professor Instructional Technology . . ." But, Gus, you forgot to say where—so try again and tell us, Did Karen make it okay? . . . I'll turn the second "oldie" into a question: How's your new (circa 1969) management consulting firm in Greenwich, Conn., doing these days, **Robert Reebie,** and Associates? A full report on accomplishments would be a fine news item for the next issue! . . . Late item! Eastman Kodak's notice reports that **John M. Sewell** has been appointed a staff assistant to the manager of manufacturing operations at the Kodak Apparatus Division, Rochester, N.Y. I'm not sure I have the picture correctly, John. Will you please throw a little light on the scene with a news flash of your own.

That's it for another school year, friends. I'm going to start a Letter-a-Month to you fellows in 1972-73. What happened to you, Tom Dolan? Well, Happy Summer 1972 to all. Just think, someday *they* might make it into a movie!—**A. J. Kelly,** Associate Secretary, 32 Scudder Rd., Westfield, N.J. 07090

45

Longfellow's Wayside Inn in Sudbury was the scene of a momentous 45 decision last evening Saturday, April 22! 1973 shall be the year of '45's second nine off-year reunion in Majorca, Barcelona and Madrid—eight days—week of April 7, 1973. The details of this '45 extravaganza will be unveiled in the Class President and Class Agent's letters this fall; suffice to say that you should set aside a week of vacation early next spring; at about $300/head you cannot afford to stay home.

At President **Tom McNamara**'s suggestion, Vice President—New England **Bill Shuman** organized a most pleasant Saturday evening in the Wayside Inn's Old Kitchen. Cocktails and Dinner for two at about $16.50 is an unheard of bargain to an expatrioted New Yorker such as myself. The intent of this gathering was to promote the Majorca trip; as you might expect there were those that had other thoughts and ideas. One of the more interesting tours was the following $42 package suggested by **Jerry Quinnan** and **Frank Gallagher;** a scenic bus tour through the Garden City of Chelsea plus six days at Revere Beach—week of February 10 only $5 extra should you elect to bring your Mrs. Suffice to say the tour has been over subscribed.

Those '45ers attending the Wayside affair were: Louise and Tom McNamara, Elaine and Bill Shuman, Ann and Bill Maglathlin, Mary and Jerry Quinnan, Dee and Frank Gallagher, Ruth and Dan Vershbow, Nancy and Charlie Hart, Carolyn and Jim Pickel, Carol and Don Kuehl from Manchester, Conn., Ginny and Roger Hood, Jeanne and Homer Eckhardt, and Fran and Clint Springer. Our local spies advise that this affair was a first for the Eckhardts and a second or a third for the Hoods; the remainder are Greater Boston regulars.

Paoli Massaglia of Fort Lauderdale is a senior partner at Massaglia, Neustrom and Bradsay, Consulting Engineers. . . . With tongue in cheek, reminiscent of his *Voo Doo* days **H. Paul Grant** advises the following: just won appointment by acclamation as Chairman of Junior High P.T.A. Shop Faculties Committee. Platform—more girls in shop course! I might add that the platform typefies our old XIII classmate! . . . Professor **Jay W. Forrester** of the Sloan School received the I.E.E.E.'s Medal of Honor at the annual banquet in New York on March 22.

Several Phi Sigma Kappa brothers and wives held a Bon Voyage party for Yuma and **Art Hall** at the Faculty Club on April 7. Art is off on a seven year safari to Cabot Corp., operation in Iran. The Hall's arrival coincided within hours of the tragic earthquake of April 10.

The March 15 Science and Government Report noted that **Alan C. Mencher** does not want to leave his post of science attache's at the U.S. Embassy, London. . . . **Norma Satten** advises that husband Joseph is now in private practice (psychiatry) in San Francisco; son, Neal a freshman at Harvard-M.I.T. program at Harvard Medical; daughter Sara, at Wellesley; middle child, Duffy now in Korea.

Your March 1 Telethon group of Dave Trageser, Jerry Quinnan, Frank Gallagher and Clint Springer enjoyed talking with the members of the following families: Randy Esten, Nick Mumford, Bill Shuman, Al Werner, Kirk Drumheller, Jake Freiberger, Paul Grant, Julian Busby, Walt Borden, Chris Boland, Pete Agoston, Ray Pelley, Pete Hickey, Jim Hoaglund, John Vozella and Tom Markey to mention just a few.

Remember the cry—Majorca, April 7, 1973.—**Clinton H. Springer,** Secretary, P.O. Box 288, New Castle, N.H. 03854

46

We are composing these June class notes in mid-April following a rain that lasted nearly 20 hours. In those past two days the lawns have gone from a brown dried appearance to a deep, rich green. Spring has to be the best season of all. We are impatient to begin the yard work but rain or wet grounds have prevented this the past three weeks. Letus hope next week end will show improvement.

I do wish that you class members would send me a short letter telling of your recent activities. Must I again resort to blackmail, coercion, extortion and threats in order to obtain the copy we need and everyone would like to read? . . . A brief note from **Cliff Woods** advises of an interesting turn in his job assignment at a large bank in New York City. Cliff has been the merger specialist at the bank but recently has been working on a special type of acquisition. His bank is the lead bank in a 53 member group which has reached agreement in principle with the trustees of the Penn Central to acquire the railroad's investment subsidiary in exchange for cancellation of $300 million debt and other inducements. . . . **Max Sacks** is working in an unusual but very successful field and has become a famed sales trainer. Max heads the Max Sacks International, Persuasive Selling Clinic of Los Angeles. During the past several years Max has conducted sales seminars directed at the sales personnel of many large, successful companies throughout the country. We understand the heart of Max's program is to teach salesmen that instead of selling your product, salesmen must sell the customer the idea of buying the product.

We have received a fine newspaper clipping from a Boston newspaper and so we should like to use this in concluding a report on **James S. Craig.** Following graduation from M.I.T. and service on the *U.S.S. Montpelier,* Jim worked briefly for G.E. and then entered Harvard Business School. While still in graduate school Jim met and married Diane Harrington in September, 1948. Upon graduation Jim worked as project engineer on radar systems at Raytheon. He left in 1954 to join Roger Sonnabend and helped to transform a real estate holding company into an integrated hotel company which became the Hotel Corporation of America. The company undertook some major expansion which became Jim's primary concern. Jim reports it all was an interesting and stimulating ex-

perience during those years with a great diversity of activities.

During the past years Jim has felt a desire to begin a new career and at the time of our reunion he was seeking a new field. From the clipping that has been sent us, we know Jim has found that new career. He is president of the Boston Waterfront Development Corp. Jim's company has announced plans for the development of the Lewis Wharf on Atlantic Ave., in Boston. The property consists of ten acres and the wharf itself which dates to the early 1800's. The first phase of the work will be to rehabilitate the historic 200,000 square foot structure. The first and second floors of this four story building are to be used for commercial and retail space. Floors three and four are to be rehabilitated and changed into 52 condominium units. A fifth and sixth floor are to be added to the building and these floors will contain an additional 50 condominium units. The building will be completed with a mansard roof and dormer windows. A swimming pool and marina will be built at the same time. Jim reports that the work will begin at once as financing arrangements have been completed. The project is expected to take two years. There are additional plans for rehabilitating the famed Pilot House and other buildings for restaurants and office rental space. Yes, Jim has found a new career and from the description, we conclude an important and exciting one. Until next time—**Russ Dostal,** Secretary, 18837 Palm Circle, Cleveland, Ohio 44126

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These notes are being written from the jury room of Common Pleas Court where yours truly has made his debut in the legal procedures of the U.S. It has been fantastically interesting to observe the wheels of justice grinding slowly forward and the people with whom I have been associated in attempting to provide the lubrication. One general comment is that I find that most people tend to be very generous in giving away the monies of others.

My apologies for missing the last issue but at least it leaves a few communiques to pass on. . . . **Bob Crandall** with his wife Lois and their five children have moved to the Pittsburgh area as U.S. Steel has transferred him from the Fairless to the Irvin works. In his new assignment Bob is assistant superintendent-production planning. . . . **Bill Coombs** has been promoted to vice president and technical director of the SOFLENS division of Bausch and Lomb. . . . **John Espey** is now associate director of the Lingjan Institute of Business Administration. . . . A graduate division of the Chinese University of Hong Kong **Fred Broderson** is now associate director of development at Xavier University in Cincinnati.

Dr. **Bob Drye** though still in practice in Carmel, Calif. has been doing some teaching and consulting in New York which has given him a chance to renew contact with his Tech friends residing in the New York area. . . . **Harl Aldrich** taught a graduate course in Foundation Engineering at M.I.T. this past spring. . . . **C. A. Rigby** returned to South Africa after graduation and now has his own consulting engineering firm. Prior to forming the firm he lectured in civil engineering in Durban and was head of the engineering division of the National Building Research Institute in Pretoria. . . . **Virginia Grammer** and husband Rex, '45, have taken up cross-country skiing to keep in shape for their bicycling. Last year they cycled some 900 miles through the British Isles with their daughter Margaret. Virginia continues her science teaching as Reg completes 25 years at Kodak.

Captain **Wayne Meyer** is in Washington with the navy as Program Manager for the new Aegis Weapons system. Aegis is the second generation shipboard anti air warfare missile system. . . . **John Kellett** has the refinery in stream in Okinawa and should now be back in the States for reassignment with Esso. As you know from the previous letter he most enjoyed his stay in the Orient and may see us at the Reunion and advise his new location.

Speaking of reunion, I trust that we saw many of you there. At least, I assume that this issue is published shortly thereafter. I contacted quite a few classmates in this area on their plans for the first week of June and the reception was quite interesting. It was pleasant to chat with **Fred Heuchling** again and interesting to realize that **Walt Ericsson,** whom I have seen occasionally on business for the past eight to ten years, was a classmate. . . . **Larry Powell** was hoping to make an appearance at the festivities but his wife's 25th at Wellesley and son's affairs at Mt. Herman may have made it very brief. Best Wishes for a fine summer.—**Dick O'Donnell,** Secretary, 28516 Lincoln Rd., Bay Village, Ohio 44140

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Dr. **Leonard J. Stutman** of St. Vincent's Hospital in New York has reported a study showing an increased frequency of heart attacks in men whose blood has a higher percentage of red blood cells. Since donating a pint of blood to a blood bank reduces the percentage of blood cells, Len and his associates have obtained Ford foundation support for a project to recruit 160 male volunteers between the ages of 30 and 50 to see if thinning their blood will reduce the heart-attack risk. In the February 28, 1972 issue of *Newsweek,* Len was quoted as saying that although proof that drawing blood will curve coronaries is a long way off, the notion still makes at least superficial sense. The viscosity of the blood is related, in part, to the percentage of cells it contains, and according to some researchers, the thicker the blood, the greater the likelihood of clot formation. The article suggested that the ancient art of bloodletting may be in for a modern revival—with judicious controls. Len Stutman's results will be of interest to all of us.

F. W. Furland has completed all requirements for his M.S. degree in management science at the U.S. International University's Graduate School of Business, San Diego. Mr. Furland is working in the Low Income Level Housing Program of San Diego which is being funded by H.U.D. . . . **Stanley Berinsky** is completing his 20th year with Lockheed Aircraft Corp. The past five years have been in sunny Northern California. Stanley is actively engaged in analysis, design, and development of electronic sensors and guidance systems for tactical aircraft and missiles. He is manager of the Advanced Programs Engineering Department.

Alfonso Cavalieri has worked with Phillip Morrison and Kent Wood at M.I.T. to publish a theoretical model that links quasars galaxies, and radio galaxies in an evolutionary sequence. Reference is made by Al and his co-authors of some motions that are apparently faster than light. . . . **Bernie Gordon** was elected a fellow of I.E.E.E. for his contributions to the analog digital interface. Also, elected was **Isaac M. Horowitz.—S. Martin Billett,** Secretary, 16 Greenwood Ave., Barrington, R.I. 02806.

49

As I write these notes, it is a beautiful April spring day with cloudless sky. Yesterday, it was literally winter with snow and 20 degree weather. The day before the temperature reached 85, a fine summer day. Good Old New England weather! Three news notes from Alumni Fund envelopes: **Herb Federhen** writes, "graduate of R.O.T.C. at M.I.T. makes good! I was promoted to Colonel in August of last year. I'm still with the Defense Special Projects Group, but will transfer to the Advanced Research Projects Agency in June. Still in the Washington area which is, at best, a mixed blessing. Family is all well, and oldest son is now angling to transfer from George Washington to M.I.T." . . . **Blair Manning** reports from Switzerland, "For past two years sales manager for North Europe and East Bloc ($200 million sales) for Caterpillar. Extracurricular winter time activities consist of study of coefficient of friction between frozen water and fiberglass, impact tests of head and hips at varying speeds and angles, hopes of *avoiding* experience of sudden torsional stresses on bone." . . . **James Wootton** reports in as Director, Research and Technology, Naval Training Device Center, Orlando, Fla.

Ted Madden is mentioned in an article on lacrosse in a recent issue of the *Boston Globe.* According to the article, Ted is still playing hockey with an M.I.T. group and lacrosse with the Boston Lacrosse Club, even though Ted claims he can't run as fast as he used to. WOW! . . . Textron announces that **Lou Peloubet** has been named controller. Lou was with Allied Chemical Corporation in New York as assistant corporate controller for 2½ years, and before that he was assistant controller for Mobil Oil Corp,, in New York. Since graduating in industrial management from M.I.T., Lou has obtained a master's degree in financing and accounting from N.Y.U., and he is also a certified public accountant.

Finally, from the University of California,

an announcement of a new book by **Gene Skolnikoff** entitled *The International Imperatives of Technology: Technological Development and the International Political System.* This magnum opus is attractively priced at $2.95 per copy direct from the Regents of the University of California.

I'm under a tight deadline so that's all for this month. Best wishes to all my classmates.—**Frank T. Hulswit,** Secretary, 77 Temple Rd., Concord, Mass. 01742

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After eight-plus years with Curtiss-Wright, working on the development of the Turbo-Compound engine (DC-7, Super-Connie), **John S. Lane** is now 14 years with Singer-Kearfott Division as Project Engineer, responsible for all attitude gyroscopes and the rate gyro assembly used in the L.M. (Apollo). . . . **Robert E. Wohler** reports that he took part in the recent telethon, which was a most pleasant experience—food, beer, conversation, etc., and produced worthwhile results for the Institute. . . . **Fred M. Bergmann** is administering a research grant program in genetics at the National Institute of Health. . . . Since June of 1950, **H. R. Nickerson** has been serving as research manager with Resistoflex Corp., in Roseland, N.J. . . . Professor **Nathan H. Cook** reports that Collie and he are still enjoying life as Housemaster and Housemistress at M.I.T.'s newest dormitory, MacGregor House. He reports that it is very busy, but fun. They would like you to stop in and see the latest trend in student housing.

Charles Y. Chittick, Jr., is now director of marketing for Steam Engine Systems Corp., in Newton, Mass. The company is developing a low pollution water based Rankine cycle steam engine for automotive use under an E.P.A. contract. The engine is expected to be fully competitive in all respects with the commission controlled internal combustion spark ignition engine. Already, tests indicate it will meet the established emission standards for 1975-76. Product line includes contract research in steam engines for automotive marine and power generation engines and engine systems, including compact, low emission on steam generators.

Among the ten educators chosen to receive the Danforth Foundation's 1971 E. Harris Harbison Award for Gifted Teaching was **John G. King,** Professor of Physics at M.I.T. Other awards he has received include the 1965 Millikan Lecture Award, the 1961 American Association of Physics Teachers Prize in connection with the competition for the development of teaching apparatus and the 1956 Sloan Teaching Award. Professor King has introduced many new methods of teaching into his undergraduate classes.

Professor **Frederick J. McGarry** chaired an M.I.T. Industrial Liaison Office Symposium in Los Angeles, January 12. Approximately 110 registrants attended the symposium on "Fibrous Reinforced Composites." He also presented an invited lecture on his research work to the San Francisco Chapter of the American Chemical Society at their monthly meeting in Oakland. . . . **Richard L. Bersin** writes from Berkeley, Calif., where he lives with his wife, Lee, and their two children, Josh and Adam. Dick tells us that he started his own business four years ago—International Plasma Corp., in which they design, manufacture, and sell low temperature plasma equipment for industrial chemical processes. For anyone wishing to write, he sends his address, 1 Edgecroft Rd., Berkeley, Calif. 94707.—**John T. McKenna, Jr.,** 2 Francis Kelly Rd., Bedford, Mass. 01730

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In April, I reported **Art Wasserman's** views on the movie M.A.S.H. and offered equal time to any philosophic film buffs. **Al Zesiger** responded: "It was one of the finest, earthiest, most refreshing movies I've seen in a long time. In these days of misdirected compassion for lost causes, it is great to see that someone can wring a little humor out of a situation which must be distasteful to all of us. To people who have been in the service, the movie comes closer to real life than historians would like us to believe." Al is president of B.E.A. Associates, Inc. (which stands for Basic Economic Appraisals) in New York City.

I have the sad task of reporting the deaths of three classmates: **Burton T. Woodward,** Cambridge, New York in February 1971; **Roy R. Benjamin, Jr.,** Tenafly, N.J., in January of this year; and **William Carmack,** Marshalltown, Iowa, also in January.

I.E.E.E. elected M.I.T. Professor, **Amar G. Bose,** a Fellow for his contributions to loud speaker design, two-state amplifier-modulators, and nonlinear systems. Amar was co-founder in 1964 along with **Charles Hieken** of The Bose Corp., Natick, Mass. Rapidly rising sales of its principal product, hi-fidelity home speakers, has resulted in construction of a new 70,000 s.f. plant. The Bose 901 is reported to lead all major speaker brands in sales dollar volume. . . . Dr. **William A. Krivsky** is the new president of Crucible Specialty Metals, Syracuse, N.Y., a Division of Colt Industries. He left General Cable Corp., where he was group vice president. . . . **Jerry C. Gilmore** writes from Suffolk, N.Y., where he is planning systems administrator with the Office Products Division of I.B.M. . . . **Zenon Popinski** is a graduate teaching assistant in the Ph.D. program at Virginia Polytechnic Institute. The Popinskis have three daughters from 8 to 11 years old. . . . **Thomas S. Rosenberg** has a new address: Charlotte, N.C.; and a new business: Grenadier Knitwear Ltd., a manufacturer of men's knit suits. The Rosenbergs also have three girls, 15 thru 11.

Littleton Strong says he is "busy trying to get a new corporation going." It's called Litva Corp., located in Canoga Park, Calif., and he's president. . . . For the last 11 years **Jules Davis,** Scarsdale, has been co-owner of Karco-Davis, Inc., performing engineering, design and general construction. He also has an interest in electrical and painting contractors. Sounds like a conglomerate, Jules. . . . From Trenton, N.J., Thiokol reports that **Paul Grady** has joined its chemical division as marketing specialist. . . . Thanks to John Dowds, Assistant Class Secretary for the following news: **Breene M. Kerr** is our most newsworthy '51er, as he has been nominated for the presidency of the M.I.T. Alumni Association. His first rate executive abilities have been recognized in business, government, and educational endeavors for the past 20 years. A senior partner in the Resource Analysis Management Group, a Director of the Kerr-McGee Industries Inc., a N.A.S.A. administrator, and in many activities on behalf of M.I.T. in Oklahoma and Cambridge, he has demonstrated an extraordinary interest in the affairs of the Institute. In 1971 Breene was awarded the Bronze Beaver for extensive and intensive participation in M.I.T. activities at local and national levels. . . . **Don Whitmore** is now a senior electrical engineer with Bertrand Goldberg and Associates. Don further reports, "We are presently designing the Charles A. Dana Building for the C.C.R.F. and the Affiliated Hospital Center. The B.R.A. is giving us a rough time." This class assistant secretary can not decipher the alphabet soup, but we don't make the news, we just report it like it is.

Ed Stringham, the president and board chairman of Penetryn International, Inc., took his company public recently with an offering of 100,000 shares at 10 cents per. Penetryn is in the pollution control (sealing sewers) biz. The family—wife, three boys and girl—are enjoying international travel and lots of skiing. . . . **Bob Pfaff** is in Harrison, N.Y., with Service Bureau Corp., an I.B.M. subsidiary. . . . Gil Lewis, E. A. Picardi, Christian Rust, Tom Meloy, and George Kostritsky all pitched in to help with the Regional Conference in Washington, D.C. . . . **Tony Mirti** is moving upward, and is now executive vice president of the Norden Division of the United Aircraft Corp. Tony was previously associated with the Ham Standard Division of United, after doing stints with Bell and Martin. He, wife Rose, and three kids live at 333 Riders Lane in Fairfield, Conn.

Who's running for office this year? Let me know and we'll give you a free plug. Regards.—**Fred W. Weitz,** Secretary, 4800 S.W. 74th St., Des Moines, Iowa 50321; **Marshall Alper,** Assistant Secretary, 1130 Coronet Ave., Pasadena, Calif. 91107; **John Dowds,** 1800 N.W. 18th, Oklahoma City, Okla. 73106; **Samuel Rubinovitz,** Assistant Secretary, 3 Bowser Rd., Lexington, Mass. 02173

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The Class of 1953 20th Reunion to be held next year is now in the active planning stages. All responses from the classmates thus far indicate that Bermuda stands out as a popular choice. **George Hegeman** is chairman of the reunion committee, and he would welcome suggestions as to desirable places to stay in Bermuda for the June '73 reunion weekend. George and perhaps other classmates will be making a sortie to the isle

in the coming weeks to check out arrangements. George can be reached at Arthur D. Little, Inc., 35 Acorn Park, Cambridge, Mass. 02140.

Recent word about some of our classmates in remote areas include: **Joan Fleckensdein Mizer,** our attractive coed geology major is now living in Wyoming and loving every minute of it. Joan is teaching high school mathematics and doing some part-time geology work. . . . **Bill Shapiro** has been working in West Pakistan for the past four years on the giant Tarbela Dam project, which lies in the Northern frontier region of West Pakistan and the nearby Indian border. Bill and wife Miriam and their two sons, Dan and Fred, are enjoying their frontier life eastern style. . . . **Harris Bixler** is now president and director of Marine Colloids in Rockland, Me. "Pete" is enjoying the rural environment surrounding his Camden, Me., home including cross-country skiing, mountain climbing, and long-distance cycling. . . . Although still living in the Pasadena area, **Bruce Murray** has been vicariously involved in the far-away exploits of Mariner 9 as it relays data from its surveillance of Mars. . . . **Bruce Beckley** has recently been appointed project manager for a nuclear power station in New Hampshire. Previous to this new assignment, Bruce had been project engineer at the Maine Yankee nuclear station.

David Berg has received considerable publicity lately because of his breakthrough in low-cost football stadium construction for the New England Patriots in Foxboro, Mass. Recently built football stadiums of equal size in other cities have been costing up to four times as much as Dave's design and execution of the Foxboro complex. . . . **Bill Gouse,** who recently was technical assistant to Dr. Lee DuBridge and Dr. Edward David in the Office of Science and Technology in Washington has now been appointed assistant dean at Carnegie Institute of Technology. . . . **Dick Linde** has recently been named assistant vice president-finance and administration at Western Union Telegraph. Among Dick's other duties is special planning for Western Union's domestic satellite program. . . . **Bill Floyd** is now assistant professor of gynecology and obstetrics at Wayne University in Detroit. Last year Bill participated in the Litchfield Lectures at Oxford University in England. . . . **Whitman Richards** has recently been appointed professor of psychology at M.I.T.

Please don't forget to send any suggestions about the Bermuda reunion to George Hegeman or myself as soon as you can; a trip to investigate possible reunion facilities will take place within the next month or two.—**M. C.** "Mandy" **Manderson,** Longley Rd., Groton, Mass. 01450

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Greetings: **Dave Howes** and **Chuck Masison** have agreed to carry the class banner as co-secretaries and with your help, produce a monthly class column. So drop a line to the undersigned and become part of it.

Paul Gray gave the principal address at the annual spring meeting of the Boston section of the I.E.E.E. where he and 11 other Boston area scientists and engineers were inducted as Fellows. As most of you know, Paul was selected to fill the newly created position of Chancellor at M.I.T. a year ago. . . . **Philip Sayre** has been selected a 1972-73 Sloan Fellow by M.I.T.'s Sloan School of Management. Phil is manager of Addressograph Multigraph Corporation's Guilford (Conn.) Division. . . . **William Zoino** presented a paper on use of rubbish as fill for building sites before the Boston Society of Civil Engineers Geotechnical Section. . . . **Charles Masison** who commuted to Raytheon's Portsmouth, R.I., facility for several years is now working back in the Waltham area. Chuck was recently elected to the Westwood school committee. Chairing Acton-Boxboro's school committee is one of **Robert Evans'** many activities. Bob recently published a book entitled *The Labor Economies of Japan and the U.S.*

Dean Jacoby passed the word that two Class members have been promoted to full professor at the Institute: **Whit Richards** in psychology and **Roy Kaplow** in metallurgy. In addition, Roy is serving as Associate Chairman of the Faculty. . . . We have some sketchy information which indicates that **Gene Brandeis** is President of Computer Link Corp.—**E. David Howes,** Jr., Box 66, Carlisle, Mass. 01741; **Charles Masison,** 76 Spellman Rd., Westwood, Mass. 02090

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It is graduation time again, and for those of you that will be back at the Institute for Alumni Days there is a fascinating series of events planned. Serving on the Alumni Days '72 Committee are Denny Shapiro and Jim Eacker.

On November 28, 1971 **Haller Van Bergen-Henegouwen** passed away. As the years go by we all become a little more aware of our mortality.

Norry B. Hersey moved to Louisville, Ky. recently, and **Robert G. McKinney** has returned to Houston, Texas after a brief stay in Pittsburgh. . . . **Lennard Wharton** has left the University of Chicago and moved to Philadelphia, where he is heading the research program of I.T.E.—Imperial Corp. One of the co-chairmen of our 20th reunion is out touring the world, looking for appropriate sites. . . . **Frederic Morgenthaler** spent the latter part of March in France, and then moved on to the Orient for April. I've gotten about as far as my power mower can take me.—**Allan C. Schell,** Secretary, 19 Wedgemere Ave., Winchester, Mass. 01890

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George Brattin has moved from New York to become manager of engineering sales for Anteus Laboratory Equipment, Inc., in Malden. . . . As reported at the reunion, **John Chichester** left Boeing three years ago and is living in an adobe hut in Mexico, making sculpture and finding contentment. . . . **Jonathan Hathaway** and Luise enjoy frequent visits to Europe. Last summer their son and daughter stayed with her parents and attended public school in Bavaria, while Jon and Luise toured Bulgaria, the Black Sea Coast, and Prague. Back in "Frisco" Jon enjoys selling computers for I.B.M.

Arthur Krinitz has been appointed a Lincoln Laboratory staff member. . . . **James Robertson** is president of the Monmouth Wine Society. He publishes a newsletter which has grown in less than a year to 12 pages with 500 subscribers in 16 states. This source of information about wine has been featured in *Vintage Magazine* and will be part of a story on wine in the *Reader's Digest.* Jim also spreads his expertise via wine tasting parties and courses at a few colleges near Fair Haven, N.J. . . . **George Szabo Bodner** has been elected vice president-investment counsel at Eaton and Howard, Inc., an investment management firm. George received his degree from Harvard Law School in 1964. Prior to joining Eaton and Howard two years ago, he was assistant vice president of State Street Bank and Trust.

We were saddened to learn from his wife, Mary, that **Richard H. Thompson** suffered a fatal heart attack last October. He had been an electrical engineer with Avco until February 1971, when he became a victim of the economic slowdown. Although Richard worked at Epsco for the summer prior to his attack, his position terminated in August. He leaves four children ages 2 to 7, and his family would be happy to hear from friends.—Mrs. **Lloyd Gilson,** Cosecretary, 35 Partridge Rd., Lexington, Mass. 02173

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We received a note from **Carl Borchert** recently in which he reported on the progress of his small construction firm. "Since leaving engineering in 1969, I have built a number of houses and have several under construction now. My wife is teaching elementary school and we have two children." . . . **John Boynton** writes that "In addition to retaining a 40-hour a week aerospace engineering job with N.A.S.A., I have recently published a book of poetry entitled *Love is Lasting,* built the frame of a cottage in Aspen, and also work part-time as a pianist, sell my artwork, and do some free-lance advertising work. Have also written a booklet for N.A.S.A. called *Launching to the Moon,* available through the Government Printing Office. Regards!" . . . **Andrew Deutsch** is president of a textile mill firm, Inta, S.A., and acting president of Tia, S.A., a variety and discount store chain.

Dick Procunier writes "we have four children now, including two girls born since our move here to Palo Alto. At this point, having failed in population control, I am working on noise pollution control at airports and recently joined Hewlett-Packard for this purpose." . . . **Richard Solo** is currently serving as Director of the Residential Counseling Program, Student Affairs, State University of New York at Stony Brook. Dick and his wife have three children; David 11, Michael

8 and Julie 5. . . . **Ronald Tweedie** is now vice-president of Tweedie Construction Co., Inc. . . . **Daryl Wyckoff** will be receiving his doctorate in business administration from the Harvard Business School this month. In September Daryl will join the faculty of H.B.S. as a lecturer on business management in Operations Management and Transportation. —**Michael E. Brose,** Secretary, 30 Dartmouth Street, Boston, Mass. 02116

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Another deadline already? No wonder I miss so many issues! Well, here goes. I had a pleasant luncheon at the Faculty Club recently with three classmates—a miniature Course V reunion: Ed Cohen, Ken Kawano and Ron Stone. **Ed Cohen** was in town for the A.C.S. meeting. Ed is currently working as the Jet Propulsion Laboratory and living with his wife and three children in Claremont, Calif. Ed received his doctorate in physical chemistry from the University of Wisconsin and spent several years working at the Pomona Division of the General Dynamics Corporation and post-doc-ing at the University of Southern California. . . . **Ken Kawano** is currently the Commanding Officer of the U.S. Materials Research Agency in Watertown. . . . **Ron Stone,** who hosted the luncheon, is presently the Executive Officer of the M.I.T. Graduate School.

John Fehen writes that since July 1969 he has been serving as Executive Secretary to the Board of Selectmen in Braintree, Mass. Prior to that, he spent ten years in San Bernardino, Calif., supervising freeway construction. John now has two sons, John Jr., 7 and Jay, 5. . . . **George Glass** relates that he is presently engaged to (sic) a project relating to the use of a neutron beam for cancer therapy. He states that although Seattle is not an economically happy city, it still beats anything back east for its environment. George hopes to be able to bring up his two daughters out there.

Jim Miller is practicing law with the firm of Greer, Popko, Miller and Foerster in the San Diego area. He bemoans the fact that he has lost touch with his Theta Chi brothers and would like to hear from all of you out there. . . . **Bill Towle,** Chief, Operations Analysis Section, Avco Corp., Wilmington, Mass., has been selected as a 1972-73 Alfred P. Sloan Fellow by the M.I.T. Sloan School of Management. The Sloan Program, started in 1931, is the oldest executive development program in the nation and is designed to provide young executives at mid-career with a full 12 months in intensive advanced study at the graduate level. The program leads to the Master of Science degree in management.

Bob Keene was recently appointed superintendent of the steel producing division's continuous billet caster at U.S. Steel's South Works in Chicago. Bob has been with U.S. Steel since graduation and his family includes his wife Donna, and three children; a son, Bruce, and daughters Kimberly and Alesia. . . . Last September, **Frank Koppelman** resigned his position as Manager, Systems Education at the Tri-State Regional Planning Commission and returned to M.I.T. to pursue a Ph.D. degree in transportation planning and economics. . . . **Bob Broder** is presently an Associate in the architectural firm of Campbell, Aldrich and Nulty of Boston, involved in housing, education and medical facilities. . . . A newsy note from fellow Course III-er and ex-officemate at Avco Corp., **Henry Oberson,** "I am now completing my seventh year with the Boeing Co., (no mean accomplishment considering the fortunes of the aerospace industry) working in their Commercial Airplane Division on metals and related problems. Family now stands at wife Bernice and two children, Heather Jo, 5 and Hank, 3."

It is with deep regret that I relay to you the news of the death of one of our classmates, **Richard F. Childs,** who passed away on October 29, 1971. On behalf of the entire Class, may I extend our deepest sympathy to his family.

I would like to take this opportunity to wish you all a good summer, and I'll see you back here in the fall.—**Arthur J. Collias,** Secretary, 61 Highland Rd., Brookline, Mass. 02146

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Richard Miller has an interesting tale tale to tell: "I am now working for my third company, but it's the companies which have changed—not me. I started with Sun Oil, moved to a subsidiary, Avisun which was in turn sold to and merged with Amoco chemicals. I'm now manager of cost and operations analysis in the polymer division. We have two girls; Julie (6) and Sara (4). My wife, Nancy, has been an active fund raiser for Simmons College—M.I.T. gets the leftovers."

Lawrence Horowitz has started his own architectural firm at 38 West 70th Street in N.Y.C. . . . **William Dyer** (M.D.) finished up a three month tour as commander of the dispensary at Phu Cat Air Base in Viet Nam last November and then moved to Udorn A.B. in Thailand where he is now Chief of Aerospace Medicine at the 432nd U.S.A.F. Hospital. . . . **Don Marquis** also moved jobs last year. His move was in July. He says he is "district manager, industrial sale for Lincoln, St. Louis." All along I thought Lincoln was a politician but Don's note goes on to say that he (it) sells lubrication and material dispensing equipment such as pumps and valves. **Clarke Swannack** says "I found the job I was looking for on my first try—so I took it before completing my thesis writing at Carnegie-Mellon. I am now involved with raising the energy of the 10 G.E.V. electron synchrotron at Cornell's Wilson Lab and I'm really having a ball—making some progress, too." My goodness, more movers.

Moving up from South Charleston, W.Va., where he was Senior Engineer for Union Carbide is **Reed Freeman.** Now he is in the Big Time as a business analyst for Union Carbide in New York. . . . **Don Easson:** "We moved last summer and now have a bigger mortgage and higher taxes. Gin teaches nursery school in the mornings and ice skates in the afternoon. The kids are in second and fifth grades and attend all the usual activities; Cubs, Little League, Brownies, etc. I am still manager of Scientific Computer Services at Atlas Chemical. Our recent acquisition by Imperial Chemical shall keep things moving." And speaking of moving **Bob Pease** says he has been "doing a lot of hiking with our boys (Benjamin 6 and Jonathan 1) and plan to join the 4,000 footer club by completing the ascents of all 46 four thousand footers in New Hampshire. Am having a ball designing fast A-to-D and D-to-A converters and pursuing abandoned railroad beds."

Harry Baya is staying just where he is in Hastings-on-Hudson, N.Y. He is in the financial planning business which "is encouraging, though the small business venture environment occasionally exhibits manic depressive tendencies." **David Newland** writes that he has been a Professor of Mechanical Engineering in the University of Sheffield in England since 1967.—**Andrew Braun,** Secretary, 464 Heath St., Chestnut Hill, Mass. 02167

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Greetings from sunny Southern California. Yours truly is continuing to seek solutions to the parking problems facing both public and private sections of American enterprise, and am kept busy by my frequent jaunts across the country. It's good to know that I am not alone in my busyness.

Promotions and transfers: **Robert A. Johnson** is being transferred to the Houston Plant of the Rohm and Haas Co., where he will preside as the chemical engineering supervisor. He is being transferred from their Philadelphia Plant. . . . It was reported on March 16, that **John T. M. Pryke** has been promoted to the position of sales manager for the Professional Services Division of the Reading, Massachusetts-based firm of P.H.I. Computer Services, Inc. . . . Keeping in touch: **Stephen Schmelling** reports that he is currently an assistant professor of physics at S.U.N.Y., in Buffalo, N.Y.

News makers: **William R. Schonbein,** Staff Associate for Arthur D. Little, Inc., has been selected as one of 49 young executives from eight countries as 1972-73 Alfred P. Sloan Fellows by the Sloan School of Management, M.I.T. . . . Because of his "outstanding contributions to the field of information theory, and his devotion to church and community affairs," **Elwyn Ralph Berlekamp** received the above citation from Eta Kappa Nu. Elwyn is currently devoting himself to a full-time academic career with a joint appointment as professor of electrical engineering, Computer Sciences and Mathematics at the University of California at Berkeley.

In an article published in the March 14 issue of *The Tech,* entitled "Smoot System", the facts and fiction behind the **Oliver Reed Smoot, Jr.**-originated Smoot System unit of measure were explained. This article originally appeared in the March 10 issue of *The Boston Globe.* . . . For his latest venture in the field of publishing, **Nicolas Charney** was featured In

the July 26, 1971 issue of *Newsweek* magazine in an article entitled "The Tycoons".—**Gerald L. Katell,** Secretary, 122 North Maple Dr., Beverly Hills, Calif. 90210

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I received a very unusual wedding announcement stating that **Jerry Luebbers** and the former Claudia Ann Rockwell were married in Spokane, Wash., on March 11, 1972. . . . **Marlin Pettit** was in Memphis recently on business. He is an assistant vice president of J. L. Hudson in Detroit. He and his wife Maureen have been married for approximately a year and a half.

Mark Alpert and his wife have a daughter approaching one year of age. . . . **Michael Auerbach** received his Ph.D. in chemistry from Cornell in 1969. He and his wife Sandy have two children, one of each sex. Michael shot an 85 on Cornell's par 72 golf course, his best effort to date. . . . **James Bahr** received his Ph.D. in biophysics from the University of Pennsylvania last year, and is now doing post-doctoral work at the University of Arizona. . . . **John Bailey** and his wife Eleanor both work at the Naval Weapons Laboratory in Virginia. John is an operations research analyst and Eleanor is a programmer. . . . **Leonard Chess** is currently engaged in research at the National Cancer Institute. Len, his wife, and their three children will soon be returning to Boston where he will be senior resident in medicine at the Massachusetts General Hospital.

Bruce Crocker received an M.I.T. Presidential Citation for his work with the San Francisco Educational Council. . . . **Harris Demetriou** is the owner of the largest ice cream plant in Cyprus. He is also a competitor in track, having a personal record of 47.8 seconds in the quarter mile. . . . **Paul Holland** is also in the ice cream business, working with his family owned firm making sundae toppings, yoghurt, etc., in Seattle. . . . **David Hoover** is the executive director of Framingham's redevelopment authority, and recently completed a series of lectures to students at Harvard's Graduate School of Design. . . . **Roger Hybels** is on active duty as a medical officer in the Air Force. He, his wife, and two children will return to Ann Arbor this summer to complete his ear, nose, and throat residency. . . . Robert notes that **Paul Clermont** and his wife Margaret visited him last fall and showed remarkable restraint in the casinos. . . . **Robert Johnston** is chief resident in ophthalmology at the Yale-New Haven Hospital. His wife Patti and he have one son born last year. Robert plans to be with the Public Health Service as of this summer.

Glenn Larson, now with the U.S. Department of Transportation in Cambridge, authored a paper on Technology and the Environment for the Institute of Aeronautics and Astronautics. . . . **Cliff Laurence** will graduate this May with a Ph.D. in E.E. from Rice University. He is an engineer-scientist with Tracor, Inc. in Austin. . . . **John O'Brien** is a product development engineer with Caltex Petroleum Corp. He spent one year in the Philippines and is in his third year in Sydney, Australia. . . . **Lawrence Rabiner** was on the faculty of a seminar held last year in the field of digital filtering. He is on the technical staff of Bell Telephone Labs. . . . **Richard Resnik** received his Ph.D. from Case-Western Reserve University in 1970, and is now working with the Navigators, a Christian organization, at Ohio State. . . . **T. S. Seay** with the M.I.T. Lincoln Lab was a guest lecturer this year at a Boston I.E.E.E. meeting.

David Slosberg is working for Honeywell and living in Belmont with his wife and two children. . . . **Robert St. Aubin** is a corporate lawyer in Philadelphia, where he is deeply entrenched in suburbia and work for the local M.I.T. Club. . . . **Bruce Strauss** is on the staff of the National Accelerator Lab and also teaches at the University of Wisconsin.

That's the news for now. Let me hear from you.—**Ron Gilman,** Secretary, 5209 Peg Lane, Memphis, Tenn. 38117

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And you thought last month's column was short. Just watch—**Walt Miller** is currently finishing his second year of pediatrics at Massachusetts General Hospital and will be joining the Heart and Lung Institute of the National Institute of Health in July. The two year assignment in Bethesda gets Walt out of the army without shaving or cutting his hair. Walt is a bachelor again and looking forward to being in Washington with the highest female:male ratio in the country (Gee, I didn't know that). . . . **Doug Spreng** became production manager for Hybrid Microelectronic Products last January. . . . **Steve Eberbach** spent 1971 at San Marco Equatorial Range, Malindi, Kenya as an experimenter's representative for Goddard Space Flight Center. A Goddard experiment built by the University of Michigan was on the Italian satellite San Marco III launched from Africa in April 1971. . . . **Tom Van Vleck** is a neighbor of your Secretary in Waltham. Tom is still working at the M.I.T. Information Processing Center.

And that's it. Thanks to those folks who did write this month, but we need more news for a real monthly column. Help.—**Steve Lipner,** Secretary, 3703 Stearns Hill Rd., Waltham, Mass. 02154

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With such a light winter, it isn't clear that we really deserve summer, but here it is! Class news has been sparse these past few months so those who have written will get full coverage this time! Several members of the Class have been traveling outside the country. . . . **Tim Carney** writes "I have returned to Washington from Lesotho and am now studying Cambodian for ten months at the Foreign Service Institute. I should be in Cambodia in late July 1972 (at the Embassy). I flew back via Munich and Athens. Going from winter in the southern hemisphere to fall and winter in D.C. is no fun!" Does anyone know where Lesotho is?

Early January found **John Adger** and his wife Carolyn in Medan, Tripoli. "We have a large house here and would welcome visitors. Medan is only a short hop from Singapore and booze is cheap here." **Pete Grant** is also somewhere in Indonesia on an assignment with Goodyear Tire and Rubber Co. (I wonder if Lesotho is anywhere near Medan?)

Michael Kraus spent the past two years in Montreal, Canada working on a Ph.D. in meteorology at McGill University. He, his wife Jane, and their first child, Pamela returned to Massachusetts this spring where Mike will work for the Air Force Cambridge Research Labs. . . . **Jeff Trimmer** has a new job as a manager with Ford Motor Company's Latin American group. Jeff plans to travel to South America and possibly Africa.

Back in the United States, there are a number of members of the Class who are finishing various degrees—**Bill Cain** plans to receive his D.B.A. from Harvard in June. He married Britt Carlson this past fall. . . . **Dave Pepperberg** is finishing his Ph.D. in biophysics at M.I.T. . . . **Joel Karlinsky** received his M.D. and is currently interning at Boston City Hospital. . . . **Hank Goldman** is attending Law School in Washington, D.C. while working for the O.E.D. . . . **Martin Kaliski** received his Ph.D. from M.I.T., this past year and is working as a assistant professor at City College of New York. . . . **John Bobbitt** finished his M.S. in math from Purdue. He intends to continue on for his Ph.D. . . . **Jim Funderburg** received his M.D., from Ohio State and began a surgical residency at Fort Campbell, Ky. He will continue his residency at Fitzsimmons General Hospital in Denver. Jim and his wife, Jane, have three children. I fully intend to present awards at the 1976 Reunion of the Class to those who are still working on degrees.

It's hard to believe that there are members of the Class that have jobs already. **John Golden** is a senior computer specialist at Polaroid in Waltham. He and his wife, Carolyn, live in Needham with their three children. John's main hobby is flying. . . . **Paul Rudovsky** reports that he is "still single living in Manhattan, and just purchased a condominium in the City." Paul is working as a vice-president of First National City Bank. . . . Emily and **Richard Levine** had their second child this past fall. Dick works in the area of career education. . . . **Tom Jones** (Thomas B., that is) is working in the Electrical Engineering department at Colorado State. Tom is one of those lucky people who has time for cross-country skiing. . . . **Bo Pasternack** is working for the Department of Transportation in Cambridge . . . and **Jim Moreland** has published an article in the Journal of Air Traffic Control, "Airport Simulation—A New Approach."

The Honorary Secretary of the Class this issue is **Gene Sherman.** I received two (that's right! two!) letters this spring from Gene. He completed Medical School at the University of North Carolina in 1970 and after an internship at Chapel Hill he continued as a first year resident. Next year he intends to take a fellowship in cardiology. Susan and Gene had their first child this past winter. Susan

will continue as a third-year medical student in endocrinology. Earlier this spring they visited **Ira Davidoff** in California where he is "practising medicine and climbing mountains."

Well troops, that's all for now.—**Tom Jones,** 33 Commercial Wharf, Boston, Mass. 02110

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This month's column of gossip will be the shortest ever. Why not send me a few words on your activities during the five years since graduation? **Charles Marantz** left his engineering job at Lockheed in Sunnyvale, Calif., and entered the M.B.A. program at Harvard. He is hoping to find a happy future in his own business. . . . A year ago **Ed Geltman** graduated from N.Y.U. School of Medicine. He is now an intern in internal medicine at Bellevue Hospital in N.Y.C. His wife Nancy received her master's degree in counseling last September. . . . **John Howard** is an assistant professor of computer sciences and a research scientist in the Computation Center at University of Texas. He received his Ph.D. in Computer Sciences from Texas in December, 1970. He has a two-year-old son, Gregory.

John Poucher married the former Lois Miriam Gross in August, 1969. John completed his Ph.D. in Physics at M.I.T. last year and is now an instructor at M.I.T. . . . I received a letter from **Ted Trueblood** who entered M.I.T. with our class but left for the war before graduating. He worked in Vietnam as an intelligence officer, a long range patrol leader, and an infantry company commander. Ted graduates this year in civil engineering, and it looks like he will pursue an S.M.C.E. Ted and Joanie have a daughter Jenney who is almost four years old.—**Jim Swanson,** 508 Thompson Avenue, Mountain View, Calif. 94040

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As the growing season reaches Northern Virginia we are learning that being homeowners is more work than it appears. The grass is growing at a good clip, but the chickweed is growing even faster and at the current rate will evict us from the house shortly. Presently we are believers in the organic way and will only use weed killers if we get desperate. More news about our attempts at organic gardening in future columns.

Class Heroes

We have two class heroes this month, both of whom earned their title by sending us newsy letters. **Dan Gruber** has switched jobs within the Merck organization and is now in the Animal Science Research Department of Merck, Sharp, and Dohme Research Laboratories, working as an internal E.D.P. consultant and assistant to the director of program planning and control. Dan comments "This new position put me more firmly in the applications end of the computer spectrum, where I prefer to work as well as providing management responsibilities." He adds that his wife Elaine (Leemon) '70 finally found something resembling a technical job last summer. She's now a programmer for Victor Comptometer, a manufacturer of small business-oriented computers. The salary and responsibilities are not great but perhaps things will pick up. . . . **Al Singer** reports that he will graduate from Columbia Med School in June and that he's planning to do his internship in the New York area. His wife, Dinah (Schiffer) '69 is working away on a Ph.D. at Columbia in biochemistry and hopes to finish in a year or two. They recently spent a month abroad visiting Israel among other places. They had been to Israel previously and the trip solidified their thinking about wanting to work there for a few years eventually.

Al reports that **Steve Straus** will also graduate in his class. Steve spent three months in Africa this fall, working in a hospital in Lagos, Nigeria for two months and then traveling around Africa for a month. One of his most memorable adventures was hearing an elephant outside his campsite while he was in a nearby outhouse at one of the nature reserves. The elephant apparently wanted to get inside so Steve made a diplomatic, if embarassing, retreat. . . . Al's letter included a long footnote from **Mike Rodburg** which must make Mike some sort of semi-hero. Mike and Roz have a daughter, Tracie Lynn, who was born in January. Mike graduated Harvard Law School magna cum laude and is now working for the law firm of Lowenstein, Sandler, Brochin, Kohl, and Fisher of Newark. . . . Mike reports that **Scott Richard** has accepted a position as assistant professor at Carnegie-Mellon Business School in Pittsburgh. He finished his Ph.D. at Harvard B School this spring. . . . He and his wife Susie will be joining **Steve Silverstein** in Pittsburgh. Steve and his wife Sue are the proud parents of a new airplane (Steve's second). . . . We also have a word from a recent class hero. **Dan Harris** made it out of the hospital in February and is currently lecturing Chem Two wearing his body cast. "A body cast is like wearing the same underwear for six months."

Working in the World

Lyn Bruneau is a systems analyst working on a project to microfilm the school's alumni records. Progress on an M.S. in geophysics is slow—"but never say die!" She hopes to move about July 1973 when her husband Bob '67 should finish his doctorate. They report missing Boston terribly, "best place in town for eating out is Burger King, or maybe McDonalds!" . . . **Karla Karash** continues to work for the M.B.T.A. but has been loaned out to the Boston Transportation Planning Review. They are studying road and public transit options for the area, which she finds very interesting. . . . **Bob Roach** is still on active duty with the Bureau of Naval Personnel. He was recently assigned a project officer for the Formal Training Data System, a part of the navy's Management and Personnel M.I.S. He finds working in a bureaucracy challenging and often frustrating but wouldn't trade the experience for anything—at least not for a while. He is also working for a master's in computer science at George Washington University.

John (Scotty) Moffatt is working on contract to the Department of Transportation in Cambridge with a couple of consulting jobs on the side to pay his rent in Arlington. He writes, "If anyone needs a warm but experienced body with an aero degree and eight years in applications programming, let me know. Have timeshare terminal at home already and am 'in the book' as the saying goes." . . . From Culver City, Calif., **Steve Toth** writes that he is serving as a captain with the Air Force and is stationed at Hughes Aircraft Co. He is married and has two children, Erika 3½ and Tony 2. . . . **Dan Greenhouse** writes that he couldn't hack aerospace E.E. He has become a professional photographer and plans eventually to be a concert pianist. He is currently involved in various projects in stereoscopic photography.

Recently we have received several requests for the addresses of classmates. We have this information available but would appreciate it if requests included a few words about what the requestor is doing. A self addressed postcard would also be appreciated. Have a nice summer.—**Gail** and **Mike Marcus,** Class Secretaries, 2207 Reddfield Dr., Falls Church, Va. 22043

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Summer greetings! As this edition of the Class of '69 notes reaches you, I will be taking up residence in St. Paul, Minn., ready to begin a life of lawyering. Until I have established a permanent place of residence in St. Paul, please send all future correspondence to the address at the end of this column. June will be a month of change for many of us. Graduate degrees of various sorts will be awarded, marriages and engagements will occur, employment opportunities will be sought or avoided, or commitments with the armed services will begin or end. If you want to avoid that accusing finger of the blue dwarf—or to demonstrate your literary talents and abilities—drop me a line this summer to let me know what you have been up to since graduation three long years ago.

I received a letter from **Robert G. McGregor** shortly after the copy for the March/April issue went to press. I began that column with a short note I had received from Bob last winter. Here is the latest installment from the continuing story of Bob McGregor in Deutschland. In January of 1970 while Bob was enrolled in a joint S.B.-S.M. program, Dr. Milton Clauser, the head of Lincoln Laboratories, gave Bob a call to find out whether he'd be interested in organizing an anti-pollution vehicle competition at the college level. Bob volunteered what time he had only to find the event mushroom into what has become known as the 1970 Clean Air Car Race. The U.S. Government granted Bob a delay from entry into active military duty until January 31, 1971. With the pressure of pulling things together for the car race, Bob almost failed to complete his thesis. His wife Beth, a graduate of Mount Holyoke

College, stayed up for five solid nights with him burning the midnight oil and typing his thesis.

Their wedding had been set for June 27 of that summer but the business of preparations for the C.A.C.R. nearly kept him out in the Midwest that weekend. Apparently, Bob was still writing the rules for the competition when his brother had to come and tell him that the ceremony had started without him. After the race in August of 1970, Bob and Beth returned to M.I.T. to write reports, produce films, publish a book, and make presentations throughout the country. Bob started up another committee in that time to continue intercollegiate events and also established a steering committee comprised of deans of engineering at eight different universities. After a brief fling with the Environmental Protection Agency as part of his military obligation, Bob is currently a platoon leader in a construction engineer battalion. Each project takes Bob and his platoon of 35 men to different locations in Europe between April and November of this year. Beth is teaching GI's basic English in a Department of Defense program designed to award them their high school diplomas before leaving the army.

Following graduation **Richard L. Partridge** had a summer job with North American Rockwell's Autonetics Division in Anaheim, Calif., before beginning his graduate work at the University of Illinois in electrical engineering. His thesis was done in the digital computer laboratory and involved the construction of digital hardware. In the meantime, Rich had received the number 48 in the lottery and had his draft board "after my bod," so after commencing work for I.B.M.'s System Development Division in Poughkeepsie, N.Y., he enlisted into the army reserves. Rich was scheduled to report to Fort Leonard Wood in Missouri for his active duty training in mid-March, after which he was looking forward to returning to work for I.B.M.

Among other notes I have received the following: **Dale Larson** is working on his Ph.D. in applied mathematics at U.C.L.A. and is living with David Pack, '68. Dale traveled around the world for six months of last year, spending a large part of his time in the India/Pakistan area. . . . **Ben Huie** was married to the former June Ellen Sota on June 26, 1971. He is working towards his Ph.D. at U.C.L.A. . . . **C. D. Bieger** completed his orals at the beginning of this year and began research for his Ph.D. thesis in the molecular biology institute at U.C.L.A. He is also managing a 16-unit luxury apartment building in West Los Angeles. . . . **Joseph H. Leiutch** recently completed his M.B.A. at the University of Michigan and is currently working in the credit department of American National Bank and Trust Co., in Chicago. . . . **Lawrence A. Steimack** entered the Mt. Auburn Hospital in Cambridge for an emergency splenectomy in November, 1971. He had minor complications but is now almost entirely recovered. Larry is now the proud possessor of an eight-inch scar and a bill from the hospital for $7500, which was paid for by insurance, "thank God."

David W. Bennett is currently studying at the Fuller Theological Seminary in Pasadena, Calif., and is planning to complete the degree of Doctor of Ministry by June, 1974. David would welcome correspondence with any alumni interested in areas of the intersection between science and theology. . . . **Larry Viehland** and Claudia (Kim) report they are alive and well in Madison, Wis. Kim quit the Ph.D. program to follow up her growing interest in teaching. She is now working on a mathematics and chemistry teaching certificate while working towards an M.S. Larry's research is going well and is expected to be completed in another one-and-half to two years. . . . **Carol E. H. Scott** is presently working in Boston City Hospital cardiovascular division and is looking forward to starting medical school at New York University next year.

Al, '68, and **Dinah (Schiffer)** Singer are continuing their studies at Columbia University. Al is in the medical school and Dinah is in her third year in the department of biochemistry. They recently returned from a month's vacation in Israel and hope to return there after finishing school. Dinah reports that **Sharon Grundfoot** is alive and well at Columbia Medical School and that **Sara Clope** is now teaching in Scituate, Mass. . . . **Robert Pratt** is working on his Ph.D. in atmospheric sciences at the University of Washington. Bob was married to the former Mary Twarowski in December of 1970 and is partially supported by a chemistry post-doctorate position held by Mary at the University of Washington hospital. . . . **Lester F. Eastwood, Jr.,** has received his M.A. degree in electrical engineering from Princeton University. . . . Lt. **James H. Black, Jr.,** is now in the U.S. Air Force and has completed one year of a four-year assignment after receiving his S.M. from M.I.T. in mechanical engineering in 1970. Jim is stationed at Wright Patterson Field, Dayton, Ohio, where he is engaged in research.—**Richard J. Moen,** Secretary-Treasurer, c/o *Technology Review,* E19-430, M.I.T., Cambridge, Mass. 02138

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For the very first time, we're able to write a column based almost entirely on letters we've received! Many thanks to all you supporters of the Post Office. As for the rest of you . . . Did you know that statistics prove that 100 per cent of the people who use envelopes to mail their letters die? A postcard will do, and it costs only 6 cents for postage and fewer trees.

Carl Dick, now living in California (it's hard to tell from his letter whether he's in Los Angeles, Hollywood, or San Francisco), writes that, after graduating, he started the Scholars Book Union. The S.B.U., which is having "considerable success in California," is an organization which entitles its members to buy books direct from publishers. Carl is currently starting the Professional Consumer-Aide Association, an L.A.-based consumer advisory service which, initially, will specialize in referring subscribers to lawyers whose fees are at least 10 per cent less for legal services than those recommended by local bar association fee schedules. On February 3, Carl appeared on the "Dating Game." His only positive comment: "I won a Schick Men's Hair-Dryer for my efforts." For those of you who knew Carl as a ping-pong maniac, he is now a volley ball maniac, and is practicing to be a sex maniac.

We received a lovely letter from **Jesse Heines,** who's been teaching at the Anglo-American School at the American Embassy in Moscow since the fall of '70. Jesse writes that, like Boston, Moscow has been having peculiar weather: last winter was the warmest in 67 years, while this winter has been cold, but with very little snow. He is still studying Russian, and can now read Pravda—"You ought to see what they say about Nixon, Angela Davis, and Viet Nam." On August 16, 1971, he and Evelyn Scott McKay were married in Edinburgh, Scotland. Evelyn, the first grade teacher at the school, is a "real Scottish lassie" who "wears kilts, loves 'Robbie' Burns, and drinks lager." Jesse and Evelyn will be returning to the States next fall(?), where Jesse plans to pursue a Doctor of Education in Science degree.

Chapman is back! Yes, **Alan Chapman** has returned to the 'Tute, and hopes to get this B.S. in Music this June! The Bearded Wonder may still be found in his old favorite haunts—the pinball room, that is. Alan is still writing music, but these days he's working with a real lyricist named Moose, and turning out some very fine stuff. No new "Get it" jokes, 'though. A couple of years ago, Alan wrote a little-known M.I.T. Alma Mater, set to the tune of a well-known popular song. Unfortunately, space limitations do not permit us to print it in its entirety, but we can, with T.B.W.'s gracious permission, give you an excerpt from this gem:

When I find myself in times of trouble,
Jerry Wiesner comes to me,
Speaking words of wisdom, M.I.T.

And when I fear I'm losing
My remaining sanity,
I'm told that that's expected, M.I.T.

M.I.T., M.I.T.,
What have you done to me?
I think that I'm O.D.'ing,
Too much technology.

And even though the night is cloudy,
There's a light that shines on me.
It must be a laser, M.I.T.

And if the light proves dangerous,
I'll go to the infirmary,
Provided it is open, M.I.T.

M.I.T., M.I.T.,
Computers running free.
I.B.M.
is at the stem
of everything I see.

George C. Allen, Jr., writes that he received his S.M., in nuclear engineering from M.I.T. in June 1971, and is presently

working on his Ph.D. in the same department. He is also serving as a member of the Sig Ep Alumni Board. George living in Winchester, and "subsisting on a fellowship with my dog Thane." . . . **Tyler Thompson** is a graduate student in chemistry at the University of Illinois, working toward a Ph.D., this year as a University Fellow, and writes us with two pieces of good news. He has been awarded a National Science Foundation Graduate Fellowship, which carries a tenure of 12 months a year for three years, with a stipend of $3600 per year. Tyler is engaged to Paula Miller of Levelland, Texas. They will be married on June 10 in Tyler's hometown of Hereford, Texas. Congratulations, Tyler, on both counts! . . . **Paul Pelke** is at the University of California at Santa Barbara, working toward his Ph.D. in rocks.

Received a long, beautiful letter from **Bob Jones** (who started out with the Class of '66, but graduated in '70). Bob, who's now living in Santa Ana, Calif., is now working at a regular ("day") job in city planning, after spending several years in the "dog-eat-dog entertainment business." He finds the job very enjoyable and feels that he is accomplishing something, although he still moonlights at music for both fun and profit. Bob describes the country and bluegrass music situation in Southern California: ". . . lots of work available but almost no musicians to take the jobs that keep opening up. My most pressing musical need at this point is for a banjo player and/or baritone singer; I could also find plenty of work for a good solid rhythm guitarist or mandolin picker who can sing a good strong lead in harmony songs and can do some solos." . . . Bob also sends us some news about other classmates: **John Zipse** has passed his prelims and is working towards his Ph.D. in Physics at U.C. Berkeley. **Ray Keithley** received his M.B.A. from U.C.L.A. last June; Ray and his bride of September, Terri, are living in Santa Monica. Ray works for a photo processing firm in beautiful downtown Burbank. . . . **Bruce Heflinger** who was pursuing a Ph.D. in physics at U.C. Berkeley, is now working towards a Ph.D. in molecular biology.

That's about it for this month. I won't even mention again how much we'd appreciate receiving more news from all of you.—**Laura Malin,** Secretary, 406 Beacon St. #1, Boston, Mass. 02115; and **Robert Vegeler,** Class Executive Committee, 511 Beacon St. A-9, Boston, Mass. 02215

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Here we are again with the tales of the Class of '71. If we're going to continue this, we're going to need help. For this issue we got some letters, but we still had to make up a lot of it. Unfortunately, it turns out that the factual letters we get are funnier, stranger, and more interesting than anything we can think up, so please help us by writing to us to let us know what you're doing (even if it isn't particularly funny, strange, or even interesting).

Phil Smith, an old Baker House person, is now living in Woburn. He wrote: 'After a June 19, 1971 wedding to Susan C. Laudato (B.S. Westfield State, Mass.) I returned to find myself laid-off my job of two weeks. After pounding the unemployment circuit for a month, I entered M.I.T. graduate school in electrical engineering and am presently in communications bioengineering. I am a T.A. in a bioelectronics lab (6.702) and a Health Science and Technology Course, Cardiovascular Patho-physiology (H.S.T. 090) in the M.I.T.-Harvard Joint Program in Health Science Technology. Comment: In order to get a temporary job, my wife had to say she had never attended college. They won't hire college graduates because they get bored and leave." Postscript: as a child, Phil had a globe, and used to Magic Marker out countries he didn't like. He is now thinking of using his M.I.T., E.E. training to build a flying saucer and a ray gun. He plans to fly around the world and use his ray gun to zap the countries he marked out on his globe when he was younger. His second choice career work is in consumer oriented electronics.

Kathy Jones is home from almost a year of teaching math and physics in Ghana for the Peace Corps. She is a bit unhappy because she can't go sailing or swimming due to a healing leg wound. She will go to Seattle, Wash., next year for graduate study in oceanography. . . . **William Dix** wrote to tell us "I'm working for the New York City Housing and Development Administration, as a staff researcher for Jim Hester '65. Plan to return to graduate school soon—either fall '72 or '73, at the latest." . . . **Len Tower** is still playing undergrad, and plans to get out after next fall. . . . **Gary Wade,** who graduated in January, is now in the navy for three years. His friends gave him a fantastic bon voyage party in Allston the day before he left. . . . **Mike Linehan** is now playing the 9—5 game, living in Wellesley.

Avi Ornstein, although graduated, hasn't gone away. He's silk-screening posters for a living, and is active in ecology-oriented groups on campus (Z.P.G., M.I.T. Ecology Action) and, of course, Alpha Phi Omega. . . . **Bruce Carlson** is planning on getting an S.B. and S.M. in E.E., Computer Science, from M.I.T. in June. . . . **Marc Alpert** is still here running the Science Fiction Society. . . . **Cathy Buckley** appreciates all those Frank Sinatra and Judy Garland pictures (one), but is still anxious for more. Johnny Ray wouldn't be bad either. Send them c/o Howie. . . . **Dave Brown,** '69-'71, wrote (in the third person) "Contrary to earlier published reports, he is not 'repainting houses' for his c.o. job. He's really doing a variety of construction work (carpentry, painting, plumbing) and supervising crews of volunteers for Low Cost Housing Corp., a non-profit organization which rehabilitates row houses in Boston's South End for occupancy by low income families. Dave is also active in the Roxbury War Tax Scholarship Fund, which funnels resisted tax dollars away from war and into life-supporting community programs." . . . **Mehdi Jazayeri** sent a note along with his class gift. He said "I am a poor graduate student at the moment. Hopefully when I start making money, I can really help." We thank him for his donation, and although the more the better, no gift is too small. . . . **J. P. Montgomery** is reported headed for Boston looking for a job. . . . **Joe Angland** is graduating this June with B.S. degrees in both economics and management. He will attend Harvard Law starting in September, and is running for his fourth term as a director of the Coop.

John Spear is graduating from M.I.T. with a B.S. and a M.S. in political science. He will be getting married this June. . . . **Ken Madell** is reported to be somewhere in New Mexico. . . . **M. K. Azima** wrote to say that he is currently a graduate student in physics at Michigan State University. He isn't too happy with M.S.U. Anyone interested in going there might want to contact him.

John Newkirk is graduating this June with B.S. degrees in management and E.E. (the computer science option). He will be attending Stanford for graduate work in computer science. . . . **Harriet Burtch** is back in the Boston area. She left for a while to have a malfunctioning kidney removed, but is now quite healthy and looking for a job. . . . We're proud to announce that **Gary J. Felser** is now our class agent. (Class agents help the Alumni Association with fund raising.) Gary, who's living in Cambridge, is working as a technical director for a theatrical group at Tufts. . . . **Gil Cohen** is graduating this June with B.S. degrees in math and chemistry. He is currently working as a grill room captain, a grader and tutor for 18.02, and doing programming work in his spare time. He hopes to go to Berkeley to study chemistry.

We will be graduating this June, getting double B.S. degrees—Howie in management and E.E. (computer science) and Leah in math and E.E. (computer science). We'll be getting married sometime this summer and will leave for Princeton University in September. Both of us will be doing computer science research in the E.E. department, working towards Ph.D.'s.

By the way, please don't forget our class gift, the Annual Kent State Memorial Lecture Fund. This past year, Leah, who's organizing things, watched the money roll in and start to earn its interest. Over the summer, she will be setting up the beginnings of a student-faculty committee that will administer the selection of topic and actual event. The first lecture is planned for next year and will use the interest we earned so far. If you have any ideas for the lecture series, please write to Leah (address at end of column). If you have any money for the lecture fund, please write to Kent State Memorial Lecture Fund, M.I.T., E19-437, Cambridge, Mass. 02139.

Keep those cards and letters coming in, folks. **Howard Jay Siegel,** Pres.; **Leah H. Jamieson,** Executive Committee Member, 26 Peverell St., Apartments 1 and 2 respectively, Dorchester, Mass. 02125

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